Exploring the Roman villa World between Tongres and Cologne

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1. Introduction

In the northwest of Europe, an extensive area of fertile loess soils reaches its most northern point between the modern day towns of Tongres in Belgium and Cologne in Germany. Between the Meuse and the Worm, the loess soil narrows considerably to less than 20 kilometres in width. The region, which today forms part of Belgium, The Netherlands and Germany, has always been favourable to human habitation, with its fertile soils, temperate climate, gently sloping hills, and a wealth of natural resources beneath the surface, such as flint, chalk, charcoal and sandstone. The area is cut by two major rivers, the Rhine and the Meuse, and numerous smaller rivers and brooks, such as the Erft, the Geul and the Ruhr. Not surprisingly humans have continuously been present in this area. It was home to the earliest farmers in the north of Europe. At the end of the Late La Tène period this region underwent a striking transformation. In circa 50 BC the Roman army, under Julius Caesar, conquered the tribes that were living here, and the subsequent usurpation of the area into the Roman Empire set in motion a transformation that left virtually nothing untouched.

The results of this transformation have been the focus of investigations since the middle of the 19th century. One hundred and fifty years later it is often assumed that the Roman landscapes in this part of the empire have been extensively studied and completely mapped and that few questions remain to be answered. In this chapter it will be argued that the mass of empirical data and publications notwithstanding, there are many issues that still require systematic analysis and interpretation, and that even some of the most basic questions regarding this landscape remain wide open. This chapter will introduce key influences for the study at hand from the fields of landscape and provincial-Roman archaeology. Then, the research project itself will be introduced.

1.1 A LANDSCAPE ARCHAEOLOGICAL APPROACH

This study aims to recreate the Roman landscapes between Tongres and Cologne and naturally the landscape-archaeological approach is seen as key. The diversity of what today is considered to be a landscape-archaeological approach is impressive however, as testified for example by a recent handbook on the subject.[1] Past landscapes have always been of interest to archaeologists, even in the pre-WWII period. The last decades have seen many changes regarding the way in which landscapes have been studied, resulting in the current diversity in landscape-archaeological approaches. Tools for the study of landscapes have also changed significantly over the years. An overview will now be presented of five different types. This by no means claims to give a complete overview of the entire field of landscape studies, but rather points out developments and issues that are seen as important to study at hand.

[1] David / Thomas 2008.

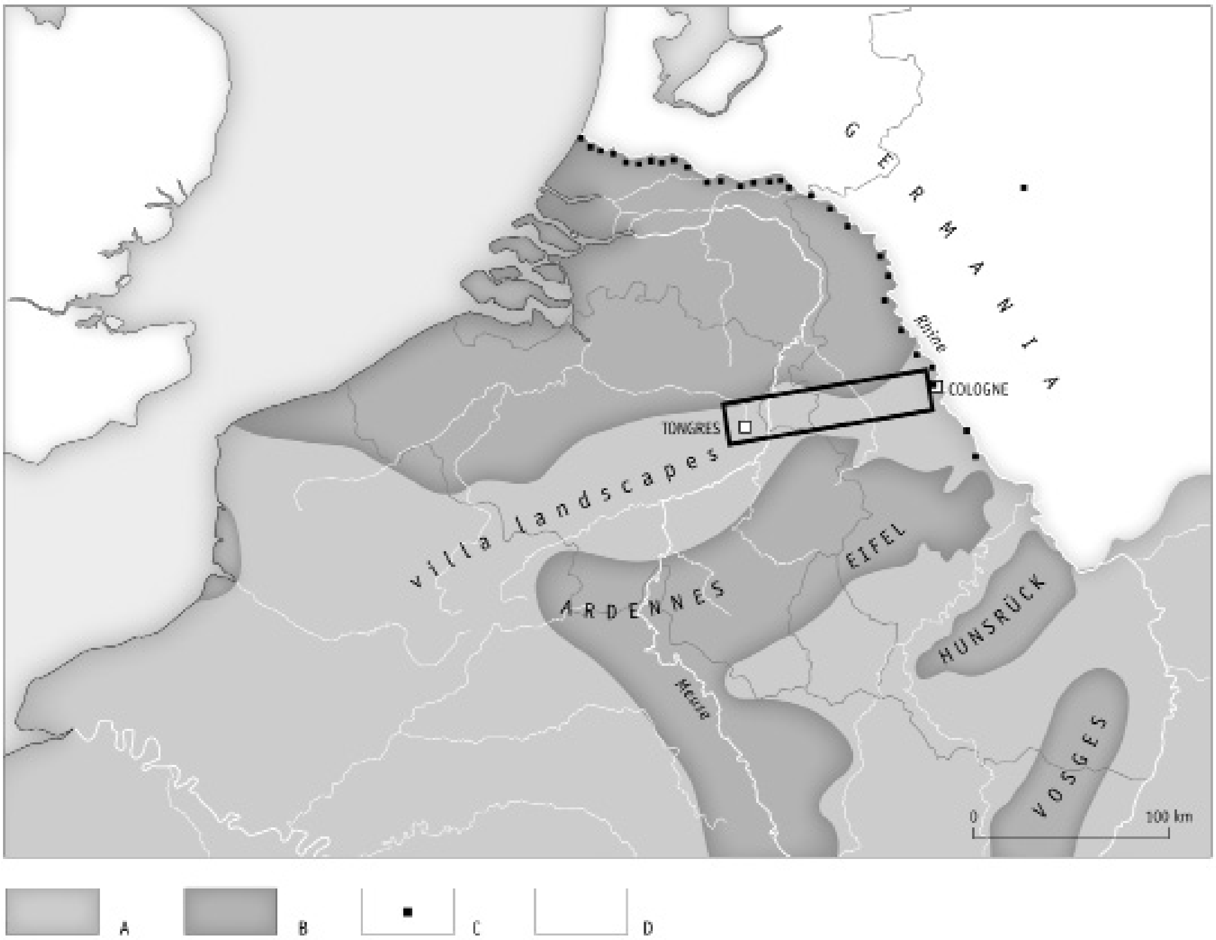


Fig. 1.1 The location of the research space (black line) in the northwest of continental Europe.
A. Loess soils; B. other soil types; C. Roman army camp; D. Image: B. Brouwenstijn, VU Amsterdam.

1.1.1 THE ECOLOGICAL APPROACH

In archaeological studies prior to the 1950s the term 'landscape' was typically used to indicate the natural environment, with elements such as soil, water, elevation and climate. This 'natural landscape' is considered to be the opposite of the 'cultural landscape' which is the environment created by humans. Used in this sense, the 'landscape' is introduced at the beginning of the research, very much like the setting of a stage, on which the 'story unfolds' of the history of a particular people in a particular period in the past. This approach is heavily influenced by different geographers from the late 19th and early 20th century, such as Friedrich Ratzel as the figurehead of geographic-determinism.[2]

There are two types of this 'landscape as a backdrop' approach: the environmentally-deterministic and the human-deterministic. In the human-deterministic view, the natural world is seen as the passive backdrop to the active human being who shapes the land and conquers the wild forces of nature. In the environmentally-deterministic approach, the natural world is seen to be the principal (and only) determining factor of human behaviour. It is the presence of a certain soil type, a river, a certain type of vegetation and climate that determines where people live, and how. In this approach it is the landscape that is active; human beings have no choice but to respond passively to the challenges nature throws at them and basically they are at its mercy.

2 Pater / Wusten 1996, 67, 69-72.

1.1.2 LANDSCAPE RESEARCH IN PROCESSUAL ARCHAEOLOGY

Under the influence of Processual or New Archaeology in the 1960s, the meaning of the term landscape and its use in archaeological research changed significantly. Due to the emphasis on analysis, patterns and processes, archaeologists embraced the concept of spatial analysis, often on a regional level. The work by geographer Walter Christaller had a profound effect on processual archaeology. Christaller believed that distance between cultural phenomena contained the key to understanding human society. He came up with the concept of the 'Central Place' in 1933, but it was not until after WWII that his ideas became widely accepted.[3] Christaller's idea that human behaviour is expressed in geographic space seemed a logical answer to archaeological queries concerning the analysis of human behaviour in the past expressed in spatial information obtained by excavations. Processual thinking made spatial information key; the identification and analysis of spatial patterns and relationships thus became a major aim of archaeological research. Key figures in this respect are Ian Hodder, Clive Orton and David Clarke with studies on spatial analysis in archaeology.[4] Hodder for example used Christaller's patterns in an article on locational models to analyse Romano-British settlement.[5] The first example of processual archaeology in The Netherlands was the Assendelver project, carried out in 1976 by researchers from the University of Amsterdam.[6] Influenced by the work of American archaeologist Kent Flannery and his Oaxaca Valley project,[7] it aimed to reconstruct the relationship between settlement pattern and natural environment using various levels of spatial analysis.[8] The natural environment was explicitly taken into account, a consequence of the ground-breaking results of paleo-botanical and zoological research that had been realised since the 1960s.

1.1.3 THE POST-PROCESSUAL APPROACH

From the 1980s onwards archaeologists became increasingly unsatisfied with the 'Positivist' nature of processual archaeology, with its emphasis on the logical ordering of patterns and on quantification. This, they felt, did little justice to the fact that human beings did more than build houses and farm their land. In the words of Andrew Sherratt: "There is more to life than porridge".[9] In his article in Archaeological Dialogues in 1996, a thematic volume on regional archaeological projects, Sherratt analyses the swing from processual to post-processual thinking by pointing out two schools of thought that are constantly alternating in European cultural and intellectual history: Enlightenment and Romantic attitudes to the past. The first can be characterized by the terms comparative, scientific, privileging rational thought, offering deterministic models, focus on order and hierarchy and stages of progress. To the second, terms like contextual, relativist, emphasising feeling and experience, sensitive interpretations of perceptible phenomena, privileging meaning and action, telling a story of individual growth and descent apply.[10] He states that each attitude entails a different approach of a regional study, concerning everything from research topics to methodology and from location of the region under scrutiny to its size. It even has consequences for the language used in such studies. Processual archaeologists typically use 'rational' terms like 'exploitation', food production', 'catchment areas', 'settlement and trade patterns'.[11] Post-processual studies use a different vocabulary with terms like 'sensitivity to the landscape, 'appropriation of nature', 'focal points of organisation' and 'gateway sites'.[12] In a typi-

3 Pater / Wusten 1996, 150-155.

4 Clarke 1977; Hodder / Orton 1976.

5 Hodder / Orton 1976.

6 Slofstra 1994, 18.

7 Flannery 1976.

8 Brandt / Leeuw / Voorrips 1979.

9 Sherratt 1996, 156.

10 Sherratt 1996, 141.

11 Sherratt 1996, 144.

12 Sherratt 1996, 146, 151.

cal post-processual landscape approach however, the main questions are not so much related to the 'economic' aspects of human life in the past, but rather to what it means to be a human being in this world. Ucko and Layton, in a publication indicatively named 'The archaeology and anthropology of landscape. Shaping your landscape' point to influential concepts such as 'dwelling' by Ingold, 'habitus' by Bourdieu and 'locales' by Tilley.[13] An overwhelming number of publications on landscape archaeology of this particular brand have come to light over the last 10 to 15 years, generating an entirely new vocabulary, with a whole new range of 'landscapes' to reconstruct, such as the obvious 'social' and 'sacred', but also less obvious ones as 'invented', 'totemic', 'ideational', 'ancestral' and 'mythical'.

A landscape in this approach does not equate a tangible form of land and it goes without saying that an entirely different methodology is needed to reconstruct such landscapes. Layton and Ucko talk about how a '*habitus'* – that was meant by Bourdieu to stand for '*a set of principles enabling people to cope with the unforeseen and ever-changing situations'* – leaves a particular 'patterning' mark on the landscape that, if done over a successive period of time, might become recognisable to the archaeologist.[14] Other archaeologists turn to the phenomenological approach (Tilley being a point in case) in which the personal sensations of a researcher at a site is central and taken to give clues about the inhabitant in that same place a thousand years ago.[15] The use of view-shed analyses has become one of the most frequently used instruments, whereby the reconstruction of 'what could be seen' from a particular point in a (tangible) landscape enables a researcher to reconstruct an image that is thought to be indicative of a past meaning.

1.1.4 German Siedlungsarchäeologie

German geographers like Ratzel and archaeologists like Kossina and Kiekebusch were very influential in developing European thought concerning the relationship between human activities and spatial patterns in the physical world, especially settlement patterns. In fact, it was Kossinna who introduced the word '*Siedlungsarchäologie'* in his publication '*Die Entstehung der Germanen'* in 1911.[16] It was thought that by studying settlement patterns, questions concerning the origin, development and demise of a tribe or group of people could be answered. After WWII however, many of these ideas were abandoned, as a result of the misuse of various elements from this school of thought borrowed by the NSDAP in the 1930s and 40s. It was Herbert Jankuhn who took German settlement archaeology to a whole new level in the 1950s. His methodology included guidelines on the type of data needed and the types of archaeology that could be used, including aerial survey and archaeo-scientific methods.[17] The natural environment forms an important factor in this type of regional research. "*Siedlungsarchäologie*" is, in a way, still the dominant form in German Roman archaeology, as illustrated for example by the publication of Bender and Wolff in 1994[18] and that of Kunow and Wegner in 2006.[19] In this type of publication the natural environment of the Rhineland is presented in separate chapters at the beginning of the publication, after which the remaining chapters present the settlement patterns and agricultural practices of different regions.

13 Layton / Ucko 1999, 2, 7, 8.

14 Layton / Ucko 1999, 12.

15 Tilley 1994.

16 Jankuhn 1977, 4.

17 Jankuhn 1977.

18 Bender / Wolff 1994.

19 Kunow / Wegner 2006.

1.1.5 THE DUTCH 'DELTA ARCHAEOLOGY'

Developments in the Anglo-American world of archaeological thinking did not have a major impact on Dutch archaeology. Nonetheless, interest for the archaeological region has always been strong, resulting in a particular research tradition, branded as 'Delta Archaeology' by the archaeologist Waterbolk.[20] This tradition of regional research was influenced by two important individuals in early Dutch archaeology: A.E. van Giffen and J.H. Holwerda. Van Giffen (1884-1973) was trained as a biologist, and advocated the use of environmental data long before the days of processual archaeology. He had a particular interest in settlement archaeology. Holwerda (1873-1951) represented the more widespread historical-philosophical tradition. 'Delta archaeology', then, can be said to be a 'melting pot', in which no one school of thought dominates, but where different approaches coincide and mix. For example, the Assendelver project, mentioned earlier, had at the beginning a clear processual character; however over the years this gave way to a more post-processual way of thinking, as seen in the work of Therkorn on houses as ritual spaces.[21] The Maaskant project, with a running time of over 20 years, shifted its focus from reconstructing a regional occupation history of the area (an aim attributed by Fokkens to Van Giffen) to obtaining insight into the history of the cultural landscape, with a focus on changes in all aspects of that landscape, such as economy, social structures and cosmology.

The *South-Netherlands* project is another example of a long-running research programme that started in the 1970s and which gradually shifted its focus during its twenty year course. In the words of Roymans and Theuws, the project went through successive phases, from 'Early Processual ambitions with a cultural-historical dressing', through 'The processual phase', to 'New areas for attention'.[22] As Slofstra indicates, this latter phase is influenced not only by post-processual thinking, but also by the historical-anthropological school at Amsterdam, which focuses on themes as state formation and integration processes.[23] The most important source of data for this project was the large scale excavations of settlements.[24] As for the methodology of the most recent phase in the South-Netherlands project, an article written in 2002 by Gerritsen and Roymans describes how the authors want to reach their aim of a long-term perspective on the dynamics in settlement and landscape in the region, by doing the following: "*We use a model of long-term agricultural cycles, set against demographic fluctuations, in an attempt to understand developments within the study region. At the same time, however, we aim to incorporate the social and ideational dimensions of these changes, which are linked to a specific ordering and arrangement of the landscape.*"[25]

It seems then that Dutch regional archaeology is yet another example of the famous 'polder-model', in being open to new schools of thought, and using concepts from them to suit the scholar's need, without ever letting go of its own roots completely. The result is a fluid approach to regional archaeology, to which new concepts can be added at any time, but with a strong tradition of looking at a regional level in order to reconstruct the history of its people.

1.2 GEOGRAPHIC INFORMATION SYSTEMS

An important development in the past decades, that greatly facilitates studies on a landscape scale, has been the introduction of user-friendly Geographic Information Systems, or GIS. Developed in the 1960s for agricultural uses in Canada, GIS-technology saw a rapid growth in applications in the following decades, in a constantly growing number of disciplines. In archaeology, GIS was first used by Mediterranean archaeologists. Gillings and Mattingly, in a publication on GIS and landscape archaeol-

20 Slofstra 1994, 20.

21 Therkorn 1987.

22 Roymans / Theuws 1991.

23 Slofstra 1994, 24.

24 Roymans / Theuws 1991, 2.

25 Roymans / Gerritsen 2002, 257.

ogy, point to a publication by Allen et al. in 1990: "*It is widely accepted that the first major impact of GIS upon the wider archaeological consciousness came in 1990 with the publication of a collection of papers entitled Interpreting Space (Allen et al. 1990). Of the 12 case-studies described in this ground-breaking volume it is interesting to note that all had a regional landscape focus*." [26] A groundbreaking example on English territory is the Wroxeter Hinterland project, carried out by Gaffney at Birmingham University, which used GIS in its aim of tracing the nature of changes in settlement and land use patterns spanning the Iron Age / Roman transition in current-day Shropshire.[27] Ever since, a growing number of archaeologists have been using GIS as a tool in landscape-archaeological studies. Its success has been such that it has become a research topic in its own right, with its own seminars, Masters programmes and special positions in archaeological units. The possibilities of storing and visualising spatial data together with a virtually unlimited number of variables, combining these with all sorts of environmental data such as elevation and soil type, and enabling a wide range of spatial analyses allow for the in-depth analysis of large regions.

Like any methodological tool, use of GIS generates a new spectrum of data, capable of answering a new range of research questions. Its use permits a different angle of approach for landscape archaeology projects. Although often described as 'a mapping tool', a GIS can do much more than visualise spatial information. According to Llobera, GIS is "*a tool capable of deriving new information which in spite of its 'map-like' appearance goes far beyond what can be represented and derived using traditional distribution maps. That is the untapped power of GIS, as a tool to visualize information that is subtle and relational in nature*."[28] Where archaeologists studying settlement patterns over a region used to produce maps showing the ancient topography projected on an underlay of relevant environmental features, a GIS enables archaeologists to visualize completely new dimensions of a landscape, not just physical, but ideational as well. A good example of a physical dimension is that of erosion. One of the distinguishing functions of a GIS is its capacity for calculations. With the right data input (slope, soil type, average rainfall and vegetation) erosion of a given area can be calculated, for every point in that area (depending on the size of the raster). Thus a map can be generated that shows in different colours the variety of erosion, indicating those locations least and most at risk.

The use of GIS in archaeology is not without its problems, as pointed out by various authors over the last few years.[29] The danger lies particularly in the easy production of impressive images that do not say anything, or worse, the application of spatial analysis tools without a proper understanding of the basics of spatial analysis or a good insight into questions of uncertainty, variables and compatibility of data. However, if used correctly, the results can be significant.

GIS has not yet been applied on a grand scale in Roman archaeology in the north. One exception is the research by Vermeulen and Antrop concerning the Roman and proto-historic roads in the former *civitas menapiorum* in the west of Belgium. The 2001 publication mentions explicitly that the methodology employed in this study differs from that used by most field archaeologists in northwest Europe, as it aims to reconstruct the '*ancient humanized landscape*' by searching for so-called 'off-site' phenomena, such as roads, ditches and field enclosures. Data for these phenomena is gathered by using aerial photography and the results of rescue archaeology and analysed with a GIS.[30]

[26] Gillings / Mattingly 1991, iii.

[27] Leusen 2002, 2-1.

[28] Llobera 2001, 1012.

[29] See for instance the article by Wansleeben / Verhart 1997.

[30] Vermeulen / Antrop 2001, 3.

1.3 PROVINCIAL-ROMAN ARCHAEOLOGY IN THE NORTH

The Roman period traditionally attracted a great deal of attention in the study area. The early proponents of Roman archaeology, in the late 19th and early 20th century, typically were classically trained members of the local elite, who looked for remains of the famed 'Roman culture' in their own backyards. Evidence of what was perceived as the 'Roman civilization' was eagerly sought and readily found, as the typical Roman use of stone, mortar and ceramic building material resulted in highly detectable sites. Not surprisingly, much of the early research focused on villa sites.[31]

The post-war era heralded many new approaches regarding provincial-Roman archaeology in general, and villas in particular.[32] In general the focus of Roman studies shifted from examining the material evidence of 'the elite', to the entire hierarchy of provincial-Roman society, in particular the 'lower' classes. In the field, new excavation and investigation techniques resulted in the discovery of structures made exclusively from organic material, such as wood and thatch. Off-site archaeology and systematic field surveys became regular features. These developments resulted in an appreciation of the diversity of settlement, and consequently in a redefinition of settlement types and the related settlement hierarchy.

As a result of the shift in research perspectives the definition of the term 'villa' has changed substantially over the last decades. It is used in a morphological sense to describe a rural settlement with distinct architectural elements; it can also imply specific social and economic traits, such as dwelling of members of the elite and surplus production for the interregional market.[33] However, it is important to point out the observation that in the study area, the villa has for the most part been studied '*in parvo*'[34] i.e. as an entity in itself, and it is being done even today. This can be considered as one of the legacies of the work done in the late 19th and early 20th century, when the early researchers identified the villa with the rich elite of the provincial-Roman society, who were thought to have a lifestyle if not identical, then at least closely resembling that of the senatorial elite in Rome.[35] In fact, fitting with the normative culture-historical approach of that era, anything 'Roman' was directly associated with 'real' Romans, as opposed to the 'uncultured' original inhabitants of the region.

Although much work has been done in the last few decades to deconstruct this dichotomy,[36] it may come as a surprise that it is prevalent even today, evidenced in, for example, local museums. Often the subject of villas is presented in line with the school of thought of the early researchers, with attention given almost exclusively to the opulence and perceived 'richness' of the material culture of Roman villas, in opposition to the 'poorness' of native settlements. Typically, the villa owner is shown dressed in a toga. Importantly, the 'villa' shown in such public settings does not represent the entire farm, but rather just the main house. This is all the more lamentable because of the availability of new data and different approaches to the subject.

The research project launched at the Archaeological Centre of the VU University of Amsterdam (ACVU) in 2006, funded by the Netherlands Organisation for Scientific Research (NWO), aimed to '*present a picture of the origins and development of Roman villa landscapes in the region between Cologne and Bavay at the northern frontier of the Roman empire, as well as to develop a new interpretative model of villa landscapes that does justice to both the socio-economic and cultural dimensions.*'[37] It was explicitly mentioned that the studies comprised in the project were to take advantage of the wealth of new data generated in recent years by contract archaeology, in combination with the large body of older data.

31 For example Habets 1871, De Maeyer 1937, and Fremersdorf 1933 illustrate the focus of these early researchers on Roman villas.

32 See Roymans / Derks 2011, Habermehl 2011a, 62 and 2011b for an overview of different definitions and meanings of the term 'villa'.

33 See for example Habermehl 2011, 17-18, for an overview of definitions.

34 Jones / Mattingly 1990, 240.

35 Roymans / Derks 2011, 20.

36 For example Woolf 1998, Mattingly 2006, Millett 1990.

37 From the research application to NWO, by Roymans.

Fig. 1.2 Excavation of the main building of the Roman villa at Vlengendaal (Dutch Limburg) in 1912. Source: Goossens archive, *Regionaal Historisch Centrum Limburg*, Maastricht.

The archaeologist seeking to investigate the Roman landscape today enjoys many advantages compared to researchers a few decades earlier. Landscape reconstruction and analysis, for example, is aided by the availability of user-friendly geo-ICT and national online archaeological databases. Thus the results of, in many cases, more than a century of archaeological activities can be used to investigate parts of the provincial-Roman landscape in the hope of obtaining new insights that go beyond the traditional. This is what the researchers had in mind when starting the Roman villa project at the ACVU, and they are not alone. In several countries in the former Roman Northwest, similar studies have been carried out in recent years. In a recent article, Haselgrove calls for the need of new research along these lines for the region of northern France.[38]

In order to develop the desired '*radically new models for understanding*'[39] the provincial-Roman societies in the northwest of the empire, theoretically informed systematic analyses of the available datasets are required. A good example of research along these lines was published in 2007. In his work on the settlement landscapes of Roman Britain , Taylor introduced several '*lines of inquiry*' to '*elucidate some key trends in rural social change in Roman Britain*'.[40] In my opinion, many of these lines of inquiry are suitable for the study at hand, in view of its scale and the nature of the data, as will be explained in the next part of this chapter.

[38] Haselgrove 2011, 45-46.

[39] Haselgrove 2011, 46.

[40] Taylor 2007, 7-10.

1.4 AIMS OF THIS STUDY

This study aims to explore the spatial order and internal differentiation of the Roman landscapes on the loess soils between Tongres and Cologne. The general objective is to reconstruct, on a landscape-scale, the main aspects of the provincial-Roman world that developed here in the first three centuries AD, thereby making use of the large body of empirical data generated over the last 150 years. It is hoped that this will result in a reliable, homogeneous dataset for this part of the empire, that can then be used to obtain new insights by means of analysis of different spatial patterns. These are for example settlement patterns: the distribution of different types of settlement, chronological patterns, patterns of dispersion, nucleation and urbanism, and the distribution of specific morphologic traits of rural settlement associated with the 'villa lifestyle'. Patterns of settlement density will be examined, as well as the interaction between the natural environment and its inhabitants by means of the relation between settlement patterns and the distribution of specific environmental factors. Patterns of non-agricultural production, as well as patterns of cosmology, ritual, and belief will also be analysed.

Different methods will be used to identify and reconstruct regional patterns across the study area and on a micro-regional level. Extensive use will be made of GIS-technology to generate the desired maps and analyse the reconstructed landscapes.

In order to achieve the research goals, the study is divided into three parts. First a map must be produced of the entire study area. This map will include every element of the Roman landscapes, such as settlements, burials, roads, but also specific sites such as sanctuaries, kilns, quarries, and any other type of site encountered in the area. This requires an extensive inventory of the empirical data for each of the three countries comprised in the dataset. For the natural environment, information is needed regarding soils, elevation, water and other natural resources. For the archaeological information, a wide range of sources needs to be consulted, such as national databases, excavation reports from the early days and recent years, and professionals and local volunteers. The resulting body of empirical data needs to be evaluated in order to assess the quality of the data. The research topics listed above will provide the necessary focus for this data analysis and evaluation. In addition, aspects such as bias, variability in archaeological practices, and reliability of both the archaeological and spatial component will be examined for each item in the dataset.

The subsequent mapping process includes the formulation of guidelines regarding the interpretation of archaeological evidence in order to ensure a uniform and reliable result, whilst at the same time allowing for diversity in data characterization. These guidelines will be inspired by the type of patterns that this study aims to reconstruct.

The next part focuses on reconstructing the settlement landscapes. This will entail a reappraisal of the dataset compiled in the first part. This reappraisal incorporates spatial information regarding Roman settlements, and detailed information regarding the lay-out of Roman settlements. It will be examined whether the use of other types of features allows for an alternative reconstruction of the settlement landscape.

The third and last part consists of spatial analyses of the recreated settlement landscapes. This includes an exploration of the various spatial relations in the region. Key in these analyses is the identification of particular patterns, in line with the research questions. The analyses will focus on the location of settlements with regard to elements of their environment, on variations in settlement densities, on the relationships between different types of settlements, and between settlements and other elements of the Roman landscape, such as burials and roads. The settlement reconstructions and corresponding settlement densities will also be used to explore related issues such as demography and land use.

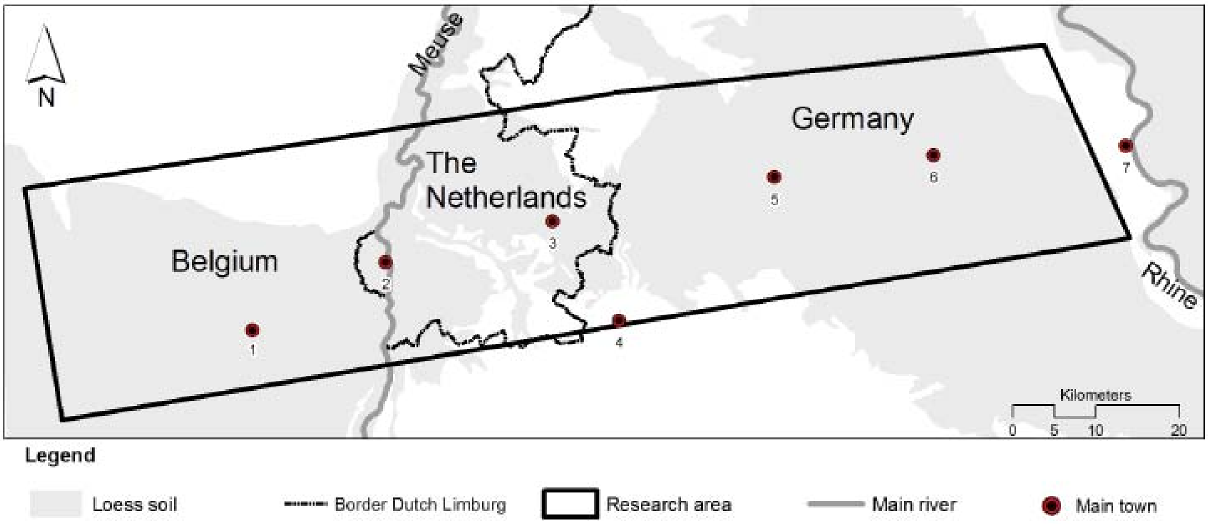


Fig. 1.3 The study area with the location of the loess soils, main rivers and modern-day towns.
1= Tongres, 2= Maastricht, 3= Heerlen, 4= Aachen, 5= Julich, 6= Bergheim, 7= Cologne .

1.4.1 STUDY AREA

The study area chosen for this study lies at the northern-most edge of the extensive loess soils belt of northwest Europe. In the original research proposal, the study area measured 60 x 30 kms and was located in Belgium and The Netherlands, between Tongres and Heerlen. The Dutch province of Limburg is the only location where the fertile loess soils are found, and this determined the placement of the study area at the northern-most edge of the loess belt. However, in the first year of the programme, it was decided to add the neighbouring German region to the study area. The main reason behind this was the wish to incorporate the high-quality archaeological data generated at by the *Ambt für Bodemdenkmalpflege Rheinlands* (the Rhineland Archaeological Services) at the lignite mining areas located between Jülich and Bergheim in Germany. Landscape-wise this addition makes sense because the natural environment highly resembles that of the Belgian and Dutch parts of the study area, with loess soils, a moderate relief, and many brooks and rivers. A conscious decision was made not to incorporate the area in the vicinity of present-day Cologne, because of the fact that this study focuses on the Roman rural landscapes on the loess soils, and the area on the west bank of the Rhine was part of the *limes*, a military zone. The addition of the German region meant that the study area doubled in size, which in its present form measures approximately 130 x 25 kms, with an area of 3,440 km^2.[41]

1.4.2 TOOLS

The use of a Geographic Information System (GIS) is an important element of this study.[42] It is pointed out, though, that this study does not aim to examine specific GIS applications, or develop new spatial analysis models. Instead, this study explores the different possibilities geo-software offers the archaeologist for mapping, reconstructing, and analysing past landscapes. It uses GIS as a tool for different spatial tasks such as the storage, mapping, visualisation and analysis of data. It allows for the explora-

[41] The study area is not completely rectangular, therefore the area is 3,440 km^2 instead of than 3,250 km^2.

[42] The GIS used in this study is ArcMap 9.3.

tion of the dataset and the different variables of each item stored. This study, therefore, should be seen as an archaeological study that makes use of different GIS applications, rather than a study about the use of GIS in an archaeological context. The problems described earlier related to the use of GIS will therefore not be addressed in this study.

1.4.3 METHODOLOGICAL TOPICS

This study will address a number of essential methodological topics with regards to the process of data acquisition, the mapping of sites, the characterisation of data and the spatial analysis of a region.

One of these topics is the definition of a site, which is seen as key because of the fact that archaeological information generated over more than a century within a specific area means that it is often unclear whether sites should be interpreted together as a single feature (settlement, burial area) or as individual, separate features.

Another topic is the assessment of the reliability of the information provided by the sources. The reliability of the reconstructed landscape can be compromised if the information turns out to be unreliable. There is a need to distinguish the information relating to the find material from the information about the location of the site, as it is not necessarily so that reliable information regarding the material found means that the locational information is accurate.

The visualisation of data is another key topic. What to visualise in a map is highly dependent on the message one tries to convey; using a GIS the possibilities of visualising data are endless. Therefore it is crucial to design a flexible system of data visualisation that contributes to the process of data analysis.

Closely related to the issue of data visualisation is the way in which sites are characterised, which in turn depends on how the evidence for each site is interpreted. Especially in the context of a dataset composed of hundreds of sites, generated over a period of more than a century, by different types of archaeological methods, in three different countries, it is imperative to set up criteria for a uniform data interpretation process, to ensure a result that can be analysed as a whole. Only then will it make sense to analyse the resulting dataset according to the guidelines mentioned earlier. Likewise, criteria have to be formulated for the reconstruction of the settlement landscape. This involves not only guidelines for the re-assessment of archaeological information, but also regarding the actual location of the site.

The reconstructed settlement landscapes can be used to calculate related topics such as settlement density and population numbers. The quality of this information is therefore dependent on the quality of the reconstruction. One of the key factors to take into account here is the influence of specific archaeological practices. Because the study area consists of three countries, the practices of these countries can be compared and this way the effect of a particular practice on the dataset can be assessed. An evaluation in this respect could help to identify possible biases in research in favour of or against any archaeological feature. This is seen as particularly important with regard to the issue of the composition of the settlement landscape.

An important element in this study consists of a range of locational analyses, in which settlement patterns are related to various environmental factors, such as soil type, elevation, and the distance to the main town. Statistics will be used to conclusively assess the assumed influence of one or several of these factors.

1.4.4 Background of the study

The present study is part of a broader research programme entitled 'Roman Villa Landscapes in the North: Economy, Culture and Lifestyles'. This programme entails four parts; three thematic studies and a synthesising study.[43] The general objective of this programme is to reconstruct the origins and development of the Roman villa landscapes in the region between Cologne and Bavay in the North of the Roman Empire, and develop a new interpretative model of these landscapes that does justice to both the socio-economic and cultural dimensions.[44]

The thematic studies differ with regard to the perspective, methodology and choice and use of sources. The key objective of the thematic study on villa settlements is to analyse developments and processes of change in rural settlements within the northern provinces of the Roman Empire, in an area stretching from the Rhine *limes* in the east to the Channel coast in northern France to the west.[45] The other thematic study focuses on the privileged burials associated with villa settlements. Striking because of their monumental markers, associated grave gifts and/or iconography, these elements provide considerable insight into various aspects of the lifestyles and identities constructed by the deceased and their survivors.[46] The present study differs from the other two studies because of its scale (landscape – large scale, rather than small scale – individual site level), its use of a wide range of data that includes every possible site generated over the last 150 years, rather than a selection of (high quality) sites, and its use of spatial analysis. In short, it can be said that the other two thematic studies are of a more qualitative nature, whereas the study at hand is inherently quantitative.

The fourth part of the programme presents an overarching perspective, integrating the themes discussed in the aforementioned studies and raising a number of new topics as well. The approach taken combines several dimensions (economic, social, institutional, individual, long- and short-term) and covers several disciplines (archaeology, classical studies and social studies).[47] The programme as a whole is able to offer a uniquely wide, synthesising and multi-dimensional view on the significant developments on the provincial countryside of the first centuries AD.

1.4.5 Scale and limits of research

The objective of a landscape–archaeological study is to identify spatial patterns that become visible only when looking on a regional, multi-site level, in order to reconstruct the processes that led to the formation and transformation of those patterns.

1.4.6 Chronological framework

The chronological scope of this study is the Roman era in the northwest of the Empire, starting with the reign of Augustus, through to the end of the third century AD. Three periods are used to date material evidence: early Roman, middle Roman, and late Roman. The early period roughly indicates the first century AD, ending after the Batavian revolt. The middle Roman period starts with the

43 Apart from this study, the thematic studies within the programme are carried out by Diederick Habermehl (in press) and Laura Crowley (in prep.). The synthesising volume contains papers as well as case studies, by several authors (Roymans/Derks 2011).

44 NWO (the Dutch organisation for scientific research) research proposal 'Roman Villa Landscapes in the North: Economy, Culture and Lifestyles' (nr. 360-60-060).

45 Habermehl 2011.

46 Crowley (in prep.)

47 Roymans and Derks 2011.

Flavian Emperors at the end of the first century AD, and ends more or less at the end of the second century AD with the last of the Antonine emperors. The late period starts with the first of the Severan emperors at the beginning of the third century AD.

The late La Tène period is not included in this study. Although the initial research programme indicated that mapping the transition from the late Iron Age to the Roman period was one of the goals of this study, the lack of good dating information regarding the late La Tène period meant that this goal was abandoned.

1.4.7 STRUCTURE OF THE STUDY

Chapter 3, called 'From sources to datasets', describes the entire process of data collection, from the consultation of sources to the visualisation and presentation of the dataset. First, it introduces the research history of the three countries comprising the study region. Then the process of data acquisition and source consultation is described, including the problems associated with the conversion of information provided per archaeological activity into sites. After this, the geodatabase is presented, with technical information regarding the database, and details on the type of information stored. Here too the issue of the reliability of information is addressed. Special attention is given to the process of data categorisation and interpretation, as this is seen as a crucial part of the data collection process.

Chapter 4, 'Exploring the Roman villa world in the North', presents the results of the data inventory phase as it introduces the dataset compiled along the guidelines discussed in chapter 3. The dataset is presented using text, graphs and maps. The composition of the dataset is analysed at length regarding the three main variables identified in this study.

Chapter 5, 'The settlement landscape reconstructed', focuses solely on the settlement landscape. It is shown how, based on observations regarding the layout of typical rural settlements, the dataset presented in chapter 4 can be used to reconstruct the settlement landscape using not only sites characterised as settlements, but also burial evidence and even sites that could not be characterised according to the guidelines set up for this study. The new settlement dataset is presented and analysed, after which it is converted into a settlement density map. The resulting map helps to identify patterns of varying settlement density, which are analysed to establish possible reasons for the variety in density. Finally, the density map is used to quantify the population of the rural landscapes in the study area.

Chapter 6, 'Settlements and their environments', consists of an extensive analysis of the (revised) settlement dataset regarding a range of environmental variables. The aim of this chapter is to establish settlement preferences and patterns in settlement behaviour.

The final chapter will summarize the main results of the study and offer recommendations for future research. First, however, the physical environment of the study area is introduced, by means of an imaginary journey from the west to the east of the study area. The aim of this description, which is illustrated throughout with photographs, is to provide the reader with a real sense of what the region looks like, and how it is to be in and move through it. Also, moving from west to east, it is hoped that the reader will experience the landscape variety.

2. On the road from Tongres to Cologne

In September of 2007, the three PhD researchers in the Roman villa project made a journey on foot from Tongeren to Cologne.[1] This journey of 110 kilometres took five days, and roughly followed the main Roman road running from west to east. The walkers covered a distance of approximately 20 kilometres a day between the different towns, that all happened to have Roman roots as either *civitas* capital or as *vicus*. In this chapter the reader will follow in the footsteps of these walkers, by making a virtual journey across the research area from west to east, covering approximately 130 kilometres in total. When walking, this would take six days, assuming a regular walking pace.

Presenting the landscape of the study area in this way, from the viewpoint of a person standing in the landscape and looking around, rather than the more traditional 'satellite view' from high above the landscape looking down, is a deliberate choice. It is hoped that the reader can obtain a sense of the region as if being in and moving through it. It does not, however, claim to recreate the actual phenomenological experience of what it is like to travel through the region. Nor does it pretend to embody the experience of a Roman inhabitant of the area, as the author is well aware of the fact that the observation was carried out by someone from the 21st century. Nevertheless, it is hoped that the combination of descriptive text and pictures will enable the reader to experience the different dimensions and elements in the landscape simultaneously, just as one would when actually walking through it.

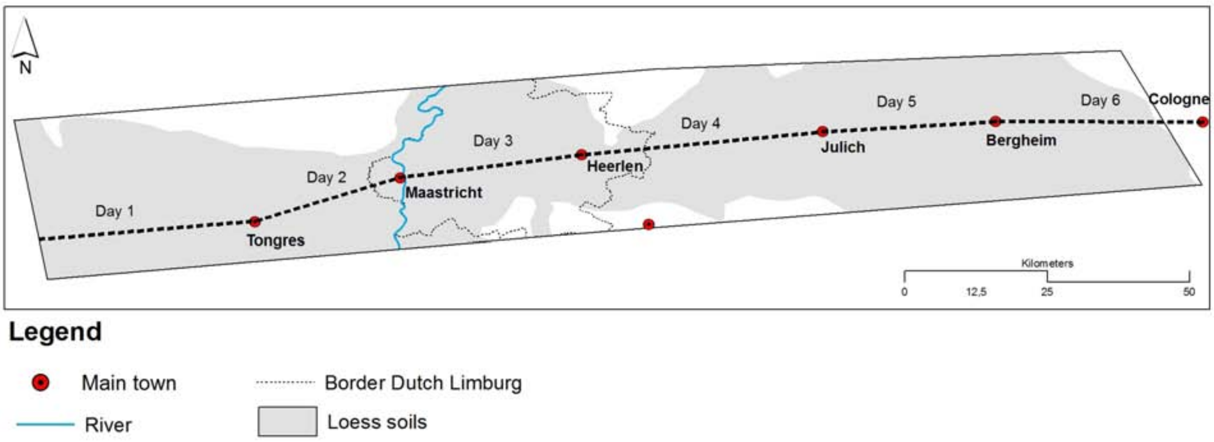


Fig. 2.1. Overview of the itinerary described in this chapter. The dotted line indicates the location of the main road.

[1] Laura Crowley, Diederick Habermehl, and the author of this study.

2.1 DAY ONE: SINT-TRUIDEN – TONGEREN

The journey starts at the point where the Roman road, coming from the west from the town of Sint-Truiden, crosses the western border of the research region. From here it is approximately 25 kilometres to the first stop, at the town of Tongeren, the location of the Roman *municipium* of *Atuatuca Tungrorum*. The gently sloping landscape here provides wide vistas of an agricultural landscape, dominated by fields and farms. In this area, height differences are seldom pronounced, and the average slope is not very steep. As a result, visibility in this region can be very high, assuming that the landscape was very open, due to the large scale cultivation in the Roman period. As figure 2.2 shows, on a dry and sunny day in the summer structures more 10 km away can be seen in this part of the region, where the majority of the land is either arable field or pasture. Of course this is substantially reduced on a wet and grey day in November, or when the landscape is planted with trees throughout.

In summertime, with the fields almost ready for harvest, there are fields of crops, like wheat and potatoes, as far as the eye can reach. In wintertime ploughed fields with the characteristic red-brown loess soils dominate the views.

A combination of loess soil and the relief make soil erosion a serious problem in this region, as anyone travelling here on a rainy day will be aware of. Once wet, loess instantly turns into sticky mud, and a downpour can cause the deposition of several centimetres of colluvium downhill (see figure 2.4). Wet days, therefore, make working the land or simply walking across a field a difficult undertaking. In the Roman period, when unpaved roads were the norm, the main road with its paved surface would have helped travellers to keep their feet dry and prevented carts from getting stuck in the mud. In the past, farmers used terracing techniques to prevent the soil erosion of loess fields, a tradition that still exists today.

Tumuli, or burial mounds, are a highly visible Roman element within the modern landscape. These structures can range in height between 1 and 10 metres, and can have a circumference of anything up to 20 metres. Although historical evidence shows that a substantial number of these earthen burial monuments have been destroyed by later inhabitants of the region, many are still visible today, especially south of the main road to Tongeren.

Fig. 2.2. The landscape west of Tongeren, captured on a sunny day in July.

Fig. 2.3. A field of wheat ready for harvest.

Fig. 2.4. Soil erosion after one heavy downpour.

The Roman road between Sint-Truiden and Tongeren crosses eight small brooks running north to south. It is assumed that these small waterways would not have been navigable in Roman times, however, they would have certainly provided the inhabitants with running water and, as such, would have been an important factor in the attractiveness of a region for settlement. No evidence has been found at any of these brooks for a bridge, which might mean that they were shallow enough to wade through.

Another indication that the brook would have been waded through, rather than crossed by a bridge, is a bend in the road at the location of the crossing. This reduces the slope to the brook, enabling carriages to travel down and back up safely. It is probable that travellers on foot would have been able to use stepping stones to prevent them from getting their feet wet.

A fair amount of gentle climbing and descending needs to be done in order to reach Tongeren. At every brook-crossing the landscape dips, after which it rises back up again. This gently undulating

Fig.2.5. A terrace (*'graft')* in a field.

Fig. 2.6. Two Roman *tumuli*, still visible in the landscape west of Tongeren today.

landscape is typical of the region west of Tongeren. On average a height difference of 20 metres has to be covered. After the penultimate brook crossing before arriving at the town, a prominent ridge of 106 metres above sea level has to be crossed, starting at a low of 40 metres at the brook. After the top of the ridge is reached, the landscape again slopes down towards 60 metres. From the top of the ridge there is a sweeping view of Tongeren and its surrounding landscape. The town itself lies on a ridge with a maximum height of 103 metres. In Roman times, the sight of a carefully planned town, with a rectangular street grid and a high concentration of white-washed buildings, some of which were truly monumental, must have made an impression on everyone arriving here. Approaching Roman Tongeren from the west, the town's aqueduct was visible, as well as a large burial field, which flanked both sides of the road. A second main road leading from *Bagacum* (modern-day Bavay) to the southwest was also visible.

Fig. 2.7. The shallow Sinselbeek, located in Dutch Limburg, with a ford visible in the background.

Fig. 2.8. The river Jeker, photographed here southeast of modern-day Tongeren, in the Jeker valley.

South of Tongeren, the small river of the Jeker passes close enough to be of use to the town. The importance of this waterway lies in the fact that it is one of the many tributaries of the river Meuse. Although it is small today, it has been argued that in the Roman period its course and width were altered to make it suitable for the transportation of bulk goods, such as grain. However, substantial evidence to back this claim is lacking.

2.2 Day 2: Tongeren – Maastricht

On day two of our journey a distance of just under 20 kilometres has to be covered to Maastricht, the location of a Roman *vicus,* which is often called *Traiectum ad Mosam*, at the border of the Meuse river.[2] Leaving Tongeren from the east-side of town, on the right side the lower lying marshy area can be seen where the Jeker and its tributaries flow. On the left the now familiar sight of a rolling landscape comes into view. Here too the land is mainly in use as farmland. On the way to Maastricht a number of *tumuli* can be seen.

Fig. 2.9. An outcrop of silex in the Jeker valley.

Fig 2.10. Exposed limestone in the Jeker valley.

[2] The first mention of the name '*Trajectum ad Mosam'* is in fact a document dated to the Middle Ages. Whether or not this name corresponds to the one given to the vicus in the Roman period, has yet to be proven. Oral information by G. Soeters, council archaeologist for Maastricht. In this study, the name '*Trajectum ad Mosam'* will be used for this vicus, in order to avoid confusion.

Fig. 2.11. An example of the use of silex and limestone used as building material in the region between Tongeren and Maastricht

Fig. 2.12. View from the top of the Sint Pietersberg, towards the southwest, looking into the Jeker valley.

Interestingly, after leaving the town, the road first descends, then gently rises back up to a high ridge. Looking back from this point at 110 metres, the town of Tongeren stands out in the landscape just like it did on the highest ridge on the west. From then on the remaining kilometres lead us through gently sloping loess fields. It is important to point out here that this landscape was significantly altered in the middle of the 20th century. In order to improve the productivity of the land, the relief was changed, with higher areas being levelled and the soil used to fill in lower lying parts of the landscape. How much was changed is unknown, but it is certain that the relief seen here today is no longer the same as the relief in the Roman period. Such activities will have undoubtedly destroyed many Roman sites, and as no archaeological records were made, the information is lost forever.

In this area two types of natural stone are found locally: silex and *mergel* (a particular type of limestone). Outcrops of silex are found at the walls of the Jeker valley; the *mergel* is quarried today at several

Fig. 2.13. View of the modern-day Maas, from the eastbank, looking towards the old town.

locations. The availability of such important natural resources for Roman architecture undoubtedly greatly added to the attraction of the region. Besides being used as a building material, *mergel* had an added bonus of being a key ingredient of Roman concrete, and even could be used as a fertilizer for the farmland.

The Roman road from Tongeren to Maastricht does not cross any rivers or brooks; instead it lies exactly on the watershed between the brooks flowing towards the north – northwest and those that flow towards the south-southeast. Although it is assumed by Belgian researchers that the Roman road more or less follows that of the modern-day road between the two towns, the exact location is not yet known.

During the last kilometres towards Maastricht the Sint Pietersberg dominates the view to the southeast. This large hill, of nearly 5 kilometres long and 1 ½ kilometres wide, rises almost 100 metres above the surrounding landscape. The Jeker river lies at its foot on the west, its flow diverted by the hill to the north, where it eventually joins the Meuse, which flows on the east side of the Pietersberg. The strategic advantage of this vast hill surrounded by waterways on two sides has been appreciated throughout the centuries. From the Sint Pietersberg, breathtaking views of the entire region can be enjoyed, and on clear days towns as far away as Tongeren to the west and the entrance of the Geul valley to the northeast can be discerned. The Sint Pietersberg is almost entirely made of *mergel.* Today the heart of the hill has almost been completely quarried away for the limestone and concrete industry.

Two kilometres west of Maastricht's town centre the road starts sloping down as it descends from the loess plateau to the river; evidence of the fact that we have now entered the Meuse valley. To the naked eye it looks like a single wide valley of 3000 to 4000m, with the river itself located more to the west. However, in reality it is composed of a wider part, higher up, and a narrower part near the base. Along both sides of the valley there are terraces that developed over thousands of years because of the changing point of the river's incision. The alluvium deposited on the terraces meant that on the valley slopes an abundance of coarse sand and gravel can be found, which make excellent building materials. In fact, in Roman times people would have been walking on the gravel from these terraces all along, as gravel embedded in clay made perfect material for road surfaces and, as such, used throughout the research region. Like all river valleys, the Meuse valley is covered by clay depositions, making it just as fertile as the loess soils, although harder to work and less permeable. Drainage would also have been a problem in wet periods.

After descending into the Meuse valley, the border between Belgium and The Netherlands is crossed at the Albert-canal which was dug here in the 1930s. Upon reaching the border of the Meuse, or *Mosa* in Latin, the splendid view of the majestic river coming from the south, flowing on one side of the Pietersberg and continuing its way to the North can be taken in. The Meuse is a rain-fed river system and therefore its volume can differ considerably during the year in response to different levels of precipitation, with extremes resulting in either an almost dried-up riverbed to flooding of the river-banks. Today the water levels of the Meuse are kept constant artificially through an intricate system of sluices, dams and canals in Belgium and The Netherlands, but it was not long ago that the inhabitants of the region had to deal with the fickleness of the river. For example, right up to the early 1920s a large area on the eastbank of the river, called the *Heugemse Overlaat*, functioned as an overflow area, so that in severe cases of high water these low-lying lands would be completely flooded, saving the inhabited areas from inundation.[3]

The strategic geographic location of the Roman *vicus* at the Meuse river cannot be underestimated. First of all, it is located on the confluence of the Jeker and the Meuse, in a natural bowl north of the Sint Pietersberg and at the foot of the loess plateau. But there is an even more important factor. Towards the south the river lies in a riverbed cut out into the bedrock of the Ardennes; to the north it flows into the sandy soils of the Kempen, where it starts to meander. In both areas building a bridge would have been very difficult southwards because of the strength of the river flow caused by the fixed riverbed; northwards because of the wide and constantly changing riverbed. The transition point from Ardennes to Kempen, where the riverbed becomes shallower, but where the river does not yet meander is the perfect location for a bridge, and it was here that the Romans chose to build one. As it was the only bridge for miles in both directions, every road converged towards it, making it one of the most important nodes in the entire network of the region. From this bridge roads led in several directions on both sides of the Meuse. A traveller in the Roman period would undoubtedly have been subjected to the control of the empire at this location.

2.3 DAY 3: MAASTRICHT – HEERLEN

On day three the journey starts by crossing the bridge over the Meuse. On the east side of the river we see how here the landscape rises up again. From between 30 and 40m in elevation on the east bank of the river, the valley slowly rises up to 100m and above on the plateau which lies straight ahead. The Meuse valley cuts what is basically one large plateau of undulating loess soils in two. Once the river is crossed, the road slowly climbs back up the side of the valley to get to the same level as it was at the end of day 2, before descending into the valley to the west of the river. However, following the Roman road, we do not go straight ahead, but instead make a turn towards the north. The main road from the vicus at the Meuse to *Coriovallum* (Roman Heerlen) stands out because of its winding character, which seems to be uncharacteristic of a Roman road. This is because the loess plateau on the east side of the Meuse is cut by another deep and wide valley, that of the Geul, which runs west-east. The main road therefore did not go back up the plateau, but curved northwards and then east into the Geul valley.

The Geul itself is a small river, comparable to the Jeker. The Geul valley is very similar to the Jeker valley, including the fact that natural stone, in this case limestone, is easily available for quarrying on both sides of the river in the valley walls. According to the latest insights, this valley formed the border between the *civitas Tungrorum*, with *Atuatuca Tungrorum* as its capital, and the *civitas Traianensis*, with *Colonia Ulpia Traiana* as its main town.[4] Crossing the Geul valley then means that we are entering a new *civitas*.

[3] Ramakers 2005, 49.

[4] See for example figure 3 in Derks 2011, 116.

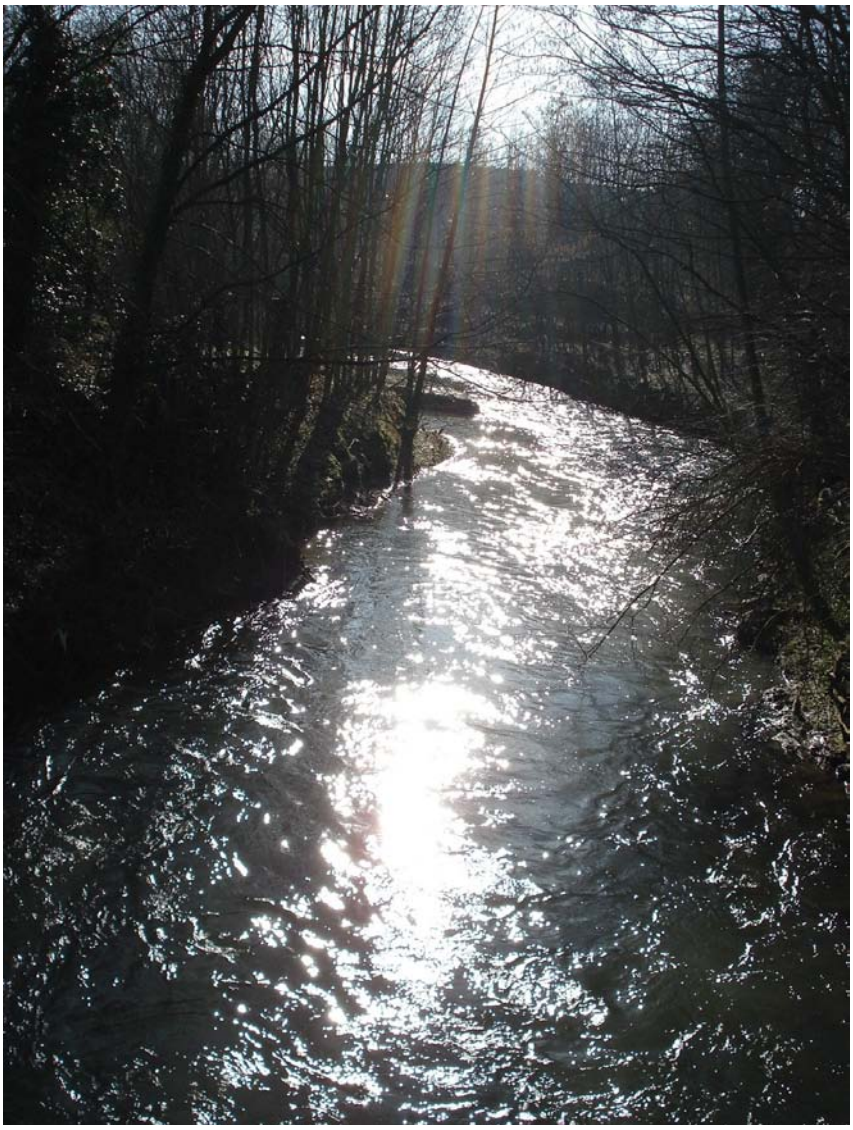


Fig. 2.14. The Geul river near Meerssen.

The Geul valley has an average width of nearly 500m and, like the Meuse valley, is covered in fluvial deposits, which means that its drainage capacity is not as good as on the plateau with a tendency to become wet and muddy in times of high rainfall. Although this makes it less suitable for settlement and arable farming, it provides excellent grazing grounds. The difference in height between the valley floor and the top of the plateaus on either side is 60 to 80m. At certain locations, visibility from the valley floor is therefore severely restricted.

Because of the fact that the valley lies almost perfectly aligned in W-E direction, there is a substantial difference in slope and appearance of the north and south sides of the valley. In the Ice Ages this region lay at the foot of the big glaciers, uncovered by ice, but frozen solid most of the time (permafrost). However, the north facing slopes were exposed to the sun, and therefore could, in warmer periods, thaw, which would make them vulnerable to erosion, but the unexposed south sides would stay permanently frozen. This resulted in an irregularly shaped valley, with one very steep side (the south side) and one gently sloping side (the north side). The consequence of this during the Roman period was that the south side of the valley formed an almost impregnable barrier to movement between valley and plateau, whereas the north side became one of the most coveted areas for settlement, evidenced by the numerous habitation sites found scattered over the valley slopes.

Fig. 2.15. The Geul valley, west of Valkenburg, looking towards the south. Here the land on the border of the river has become a protected natural monument with uncontrolled vegetation. It is possible this type of vegetation resembles that of Roman times at the valley floor. At the far side of the valley the different ridges, or '*kapen*', can clearly be seen.

Fig. 2.16. An example of a hollow leading from the plateau into the Geul valley.

Another natural process further added to the advantageous location of these slopes: drainage of water from the plateau into the valley caused incisions, which over thousands of years turned into valley-shaped hollows. On the shallower slopes on the north side, these became the natural pathways up the plateau. Hollows cut out in the southern valley slopes, although usable, were too steep for most traffic, especially for wheeled vehicles with cargo. As a consequence, the plateau north of the Geul valley was far more accessible from the main road than the plateau south of it.

Halfway into the Geul valley, at the location of modern-day Valkenburg, the Roman main road to *Coriovallum* traversed the plateau to the northeast. The point where the road left the Geul valley is approximately the point where the valley itself starts to bend towards the southeast, as the source of the Geul is located in the Eifel, southeast of Dutch Limburg. Going to Heerlen, the road goes up the plateau to the northeast. After completing the 50 to 60 metres climb from the Geul valley to the

Fig. 2.17. Quarry of Kunrader limestone (the *Putberg* quarry), west of Heerlen.

Fig. 2.18. Use of Kunrader limestone in a farmhouse near Voerendaal.

top of the plateau, the modern-day town of Heerlen can be seen not far off into the distance. This town is built on top of the remains of the vicus of *Coriovallum*. In a situation similar to that of on both sides of Tongeren, the Roman main road first crossed a high point, reaching 130 metres, after which it descended to 80 metres, and then slowly climbed to 110 metres again at on reaching the vicus. The strategic advantage of such an approach should not be underestimated: from the town, anyone approaching it would have been spotted miles away (7 kilometres in this case, 7 ½ kilometres in the case of Tongeren).

From its high point on the northern plateau, the route leads down into the brook system of the Geleenbeek. From this point eastwards the hills on the right consist of a different type of limestone known by the name *Kunrader*. The difference lies in its hardness: it is much harder than the *mergel* found at the surface between Tongeren and Valkenburg. The Kunrader-limestone cannot be sawn, like the *mergel*, but must be hewn, and because of its hardness it can better withstand exposure to the elements. In the Roman period it was also used for the construction of the main body of the road at this particular stretch. Not surprisingly, throughout history houses in this region have been made of roughly-hewn Kunrader limestone. The additional advantage of Kunrader limestone is that the deposits are easily accessible in the hollows on the edges of the plateau, Quarrying this stone is easily achieved by standing on the edge of the plateau and hacking through the rather soft stone from top to bottom. The main Roman road here led right along the foot of the Kunrader deposits, and can be assumed that this was not only done to avoid the marshy basin north of it, but also to be as close as possible to the Kunrader quarries.

After passing the Kunrader stone quarries on the right, we arrive at our destination of Heerlen. Before entering the *vicus*, a Roman traveller would have seen a large cemetery on both sides of the road, stretching out for nearly one kilometre. Similar cemeteries were found alongside all four main roads leading into the *vicus*. On the west and east side of the Roman town, the two brooks of the Geleenbeek and Caumerbeek formed the border between the settlement and the cemetery. *Coriovallum* was located at a crossroads of two important main roads: the road from *Atuatuca Tungrorum* to *Colonia Claudia Ara Agrippinensium* and the road from *Aquae Granni* to *Colonia Ulpia Traiana*. And just like *Atuatuca Tungrorum*, it was located on a ridge between two lower-lying areas.

One of the main attractions of the town was undoubtedly its bathhouse. Located strategically between the two brooks, so that the higher one (the Caumer) could be used for the supply of fresh water, and the lower one (the Geleen) for the disposal of sewage, the *thermae* of *Coriovallum* were the ideal place for any traveller to wash away the dirt accumulated during days of travel. Another remarkable feature of the *vicus* was the large number of ceramics workshops. North of *Coriovallum* large deposits of white clay of good quality are found, so it is not surprising that this natural resource led to a flourishing ceramics industry here.

The main attraction of *Aquae Granni* undoubtedly was its baths. Located less than 15 kilometres southeast of *Coriovallum*, it boasted some of the best bath houses in the region. This was because natural sources fed its *thermae* with pure spring water, which was well known for its beneficial effects. In fact, it seems to have been purposely built for the recreation of Roman soldiers on leave, like several other of these thermal bath complexes in the Roman provinces. The town had a quadrangular layout and was founded under August, at around the same time as *Atuatuca Tungrorum*.

The road from *Coriovallum* to *Aquae Granni* slowly rises from 110m to 185m at its highest point, about 3 ½ kilometres from the town. Then the road descends rapidly, to the valley of the Wildbach and Schwarzbach brooks; two tributaries of the Worm river. After crossing these two brooks, at 160m, the road then slowly ascends to 175m at the heart of the Roman vicus. The town is located in a natural bowl in the northern Eifel massif, behind a very distinct hill called the Laurensberg, which towers over the area at nearly 100m above its surroundings.

The area surrounding Heerlen was until the 1970s one of the most prosperous regions of Limburg thanks to the many coal mines located here. From the late 19th century, it was the centre of intensive development connected to the coal-industry, with the construction of new mines, railroad tracks, and so-called *kolonies*, specially designed villages for the miners and their families. These developments unearthed a large number of Roman features. In this region the only Dutch example of a completely excavated and published villa site can be found, at Kerkrade-Holzkuil.

2.4 DAY 4: HEERLEN - JÜLICH

Day four covers the land between Heerlen and Jülich, location of the Roman *vicus* of *Iuliacum*. At approximately 27 kilometres, this is the longest stretch of the journey. It takes us from Dutch into German territory, with the border located at the Wurm river.

In Roman times a traveller leaving *Coriovallum* would have passed through another roadside cemetery, this time starting on the east bank of the Caumer brook. The road then slowly rises to 145m, after which it descends into the Worm valley. The Worm is comparable to the Geul in size, which means that it cannot be crossed without the aid of a bridge. At the village of Rimburg the remains of a Roman bridge was found, together with evidence of a small nucleated settlement, consisting of several long, narrow houses on both sides of the Roman main road.

Fig. 2.19. The Worm valley, looking towards the northeast. On the right the eastern slope of the valley is visible.

Fig. 2.20. The landscape east of the Wurm.

Fig. 2.21. The Rur river near Jülich.

After crossing the Worm, and entering German territory, the road climbs the eastern slope of the valley, the top of which lies approximately 30 metres higher than the valley floor. Arriving on the edge of the plateau, there are 15 more kms to cover towards the east, before arriving in the town of Jülich. During this part of the journey the landscape is remarkably flatter than in the days before. The plateau between the Worm and the Rur rivers undulates between 110 and 120 metres, before descending into the Rur valley.

5 kilometres after crossing the Wurm, the village of Baesweiler is passed. Here too, remains of a roadside village were found, comparable in size and character to the settlement at Rimburg. Continuing eastwards, the Roman road ran in a straight line towards the Rur valley, but instead of crossing it straight on, it made a sharp turn towards the south, before crossing the valley and entering the vicus of *Iuliacum*. This detour could have served to shorten the stretch through the lower-lying and undoubtedly wetter and muddier valley floor, but maybe the reason lay in the fact that, here, the Rur was easier to cross. Another possibility would be that the 'bend in the road' was a safety precaution, although the lack of a similar bend in the road east of the vicus seems to work against this theory.

The modern-day landscapes west and east of the Wurm could not look more different. On the west-side we find one of the most densely populated regions of Limburg, with the towns of Heerlen and Kerkrade forming one large conglomeration, whereas on the east most of the land seems to be used for agriculture. However, upon closer inspection, it becomes clear that the landscape here is filled with reminders of industrial extraction of natural resources, such as sandstone, silver-sand and coal. Although coal mining is a thing of the past in this region, enormous slag heaps are vivid reminders of its extensive activity.

Coming closer to Jülich, there is evidence of even more extraction activity, as the power-plants that are fed on the lignite, mined in the Weisweiler open-air mine, southeast of Aldenhoven, become visible on the horizon. Since the 1970s the land due to be destroyed during lignite extraction has been thoroughly investigated by archaeologists of the *Ambt für Bodendenkmalpflege Rheinland*. This has resulted in an extensive dataset of Roman sites including complete farmyards, burials, secondary roads and various craft activities besides farming. The area southwest of Jülich has yielded a rich Roman landscape, in which many sites have been fully excavated. The picture this gives us is of a densely populated rural landscape.

The *vicus* of *Iuliacum* was located strategically on a slightly higher area in the valley of the Rur, where several smaller brooks enter it, such as the Ellebach and Iktebach. Two and a half kilometres to the south, the river Inde joins the Rur.

Although the Rur is considerably smaller than for example the Meuse, it would have been a considerable obstacle, especially for wheeled transport and the remains of a bridge found at the westside of the *vicus* seem to substantiate this assumption. The *vicus* itself stretches out along the main road for nearly one kilometre. No doubt a number of Roman officials would have been stationed at the *vicus*, with the main duties of controlling the traffic on the main road and overseeing the collection of taxes. *Iuliacum* also had a number of pottery workshops, and cemeteries can be found on both ends of the *vicus*. The one on the east is larger in size, probably because space on the west side is limited, with most of the surrounding land being low-lying valley ground.

2.5 DAY 5: JÜLICH–THORR / BERGHEIM

On day five the distance between the towns of Jülich and Bergheim has to be covered, which is just under 20 kilometres. The landscape surrounding us today is still quite flat, especially in comparison to the landscape in South-Limburg. Not surprisingly, these plains are called '*Platte*' in German, meaning flats. The plains on the east-bank of the Rur vary in height between 60 and 90 metres. However, starting out on our journey there is a large hill right in front of us. This is not a natural hill, but the *Sophienhohe*, the tangible result of the Hambach mine workings, which lie behind it.

The Hambach area was covered by forest for most of the post-Roman period (hence the name *Hambacher Forst*, meaning forest of Hambach). When digging activities for the new lignite open-cast mine were started in the late 1970s, nearly 6 kilometres of the Roman main road from *Iuliacum* to *Tiberiacum* and the adjacent plots were thoroughly examined by the *Ambt für Bodendenkmalpflege Rheinlands*, with many sites excavated completely. The result is an unprecedented view of a Roman roadside settlement landscape.

On our way eastwards from Jülich the route passes through the village of Elsdorf, where remains of another roadside settlement were found. It is from here that the modern main road going west lies on

Fig. 2.22.View from the *Sophienhöhe* towards the east, with the open-cast mine of Hambach on the right.

the exact same location as the Roman main road. According to antique maps, a town with the name of *Tiberiacum* was located between *Iuliacum* and *Colonia Claudia Ara Agrippinensium*. Unfortunately, very little is known about this settlement. Finds at modern-day Thorr, just south of Bergheim, seem to point towards a *statio*, rather than a town.[5] Interestingly, if this is *Tiberiacum,*it means that the settlement was not located in the proximity of the river Erft, but approximately 2 kilometres west of it. The Erft runs almost parallel to the Rur, coming from the south and flowing towards the northeast, where it joins the river Rhine at the location where the Romans built one of their *castella*, at *Novaesium*, modern-day Neuss.

2.6 Day 6: Thorr / Bergheim – Cologne

The final day of the journey will entail steep climbing and descending, as we have to cross the '*Villen'* that we can see straight ahead of us. The '*Villen'* is a range of hilltops that owes its distinct appearance to a genesis different from that of the loess plateau west of it. In actual fact it is one and the same formation and the *Villen* are just as fertile as the plains. Stretching out from north to south, it encloses the loess plateau on the east side, and forms the final barrier before the road drops down into the Rhine valley towards the town of Cologne. In the northern parts of the *Villen*, a particular type of sandstone, called *Grauwecke*, can be found and it is this stone that was used most often for the construction of houses in the Roman period. There are also numerous sources, four of which were used to provide the town with water before the Eifel aqueduct was built: those at Knapsack, Berrenrath, Aldenrather Burg and Bachem.[6]

Fig. 2.23. The landscape west of Cologne, after descending from the *Villen* hills into the Rhine valley.

[5] Andrikopoulou-Strack 2004, 169.

[6] Eck 2004, 361.

Fig. 2.24. The Rhine river at Cologne; the modern bridge lies at almost the exact same location as the Roman bridge.

Starting out at approximately 60 metres elevation on the Erft valley floor, we face a steep climb to the highest point of our journey, rising over 150 metres in just 3 ½ kilometres. From this point on the road descends more than 100 metres over the final 17 kilometres of the journey. In the Roman period the elevation would have been less, because the hilltop at 150 metres is artificial, another by-product of the lignite extraction.

As soon as the highest point on the journey is crossed, the Rhine valley opens up in front of us and the town of Cologne is visible in the distance. The eastern slopes of the *Villen* are more gradual than the steep slopes on the west side, and provide sweeping views of the valley, the river and the hills on the other side of the Rhine. Most of the Rhine valley consists of fluvial deposits, which makes it equally as fertile as the loess plateaus, although it can be harder to work under certain circumstances. The fertile ground, the gradual slopes, the abundance of fresh water sources, the sweeping views of the entire valley, the protection by the higher *Villen* against the strong winds across the plateaus and the proximity to the town of *Colonia Claudia Ara Agrippinensium* no doubt made this area very attractive to settlers. It did, however, also mean being very close to the border of the Roman empire, making settlements in the direct hinterland of the army camps and towns prime candidates for attack by invaders. Finally we have reached our final destination of Cologne, on the border of the Rhine.

3. Mapping the landscapes: from sources to datasets

The reconstruction of any archaeological landscape is only as good as its basic components. It is therefore important to explain how the datasets were compiled: how the information, generated by several people, through a variety of methods over a long period, was combined to form a homogeneous dataset and what sources were used.

In light of the aim of this study, only geospatial data was to be used: data that referred to objects or phenomena with a specific location on earth.[1] Most archaeological research entails the visualisation and analysis of data with a spatial component. Although this is hardly a new observation (see for instance Clarke 1977[2]), it is rarely acknowledged by archaeologists, even though most studies perform such analyses and visualisations. This is evidenced by the fact that in many archaeological studies little or no reference is made to the techniques of visualisation or spatial analyisis used in the mapping or modelling processes. In landscape archaeology especially this can cause problems, as mapping and reconstruction needs to be done on such a scale that even a small mistake can seriously influence the research results. Furthermore, many landscape-archaeological studies consult a wide variety of sources in order to obtain sufficient data for the reconstruction of a region. However, an appraisal of the differences in the quality of these sources is not always provided. As these differences can seriously influence the reliability of the outcome of the research, a critical review of the sources should be an important step in the process. This chapter presents the history of research in each of the three countries, so that the different sources used can be understood in the context of the local research history. The data acquisition process itself is then introduced in 3.2, with an evaluation of the quality of the information and the differences between the resultant datasets. Part 3.3 describes how the archaeological information was stored and visualised using GIS technology, and how this improved the quality of the resulting dataset. Crucial in this process is the conversion from field data to archaeological features and structures relevant to the research questions. Chapter 3.4 will describe how this was done, discussing data interpretation and classification.

TERMINOLOGY

In this study the terms 'site', 'item', point, and 'feature'/'structure' are used to describe different things. It is important to define what they mean at the outset to prevent confusion. The word 'site' is used in a general sense, to indicate a place where archaeological remains are found. Individual find-spots, registered in the geo-database, are called 'items'. When visualising the dataset, in the form of maps, these items are also referred to as 'points'. The words 'feature' and 'structure' are used to indicate archaeological phenomena, for example, a burial field or a road. The range of features used in this study and corresponding criteria will be discussed in part 3.3. Whether site, item, point, or feature, all can refer to point locations, lines or polygons, depending on the information provided by the source. In the end, however, all features and structures registered in the database are represented by point locations.

1 Kraak/Ormeling 2003, 3.

2 Clarke1977.

3.1 SOURCES AND THE HISTORY OF ARCHAEOLOGICAL RESEARCH

3.1.1 DUTCH LIMBURG

In an essay published in 1947, A.W. Byvanck gave an overview of Dutch archaeology in the period 1922 to 1947.[3] He indicated that although a great deal of attention had already been devoted to the Roman period in South-Limburg, further investigations were necessary. He noted that account should be taken of, not just the villas, but also the simple farms, small urban settlements and other elements, such as roads.[4] Byvanck's overview indicated that Roman villas were one of the few types of site to have attracted a great deal of archaeological attention as early as the 19th century in The Netherlands. The first half of the twentieth century saw rapid changes in the Limburg landscape, with the construction of several railroads, new houses, improvement of roads, and the digging of channels for shipping. As a consequence, many archaeological remains were unearthed. These were inspected and retrieved by local individuals, such as Habets and Goossens.[5] It is important to note that these early protagonists had not had any training as archaeologists, as it was not yet considered a discipline in its own right.[6] Between the 1890s and the 1940s over twenty villas were excavated. Typically only robber trenches and wall foundations of the main house of the settlement were investigated.

Interestingly, little archaeological research was carried out on Roman villas in the 1950s and 1960s. The villa of Voerendaal was the only site to undergo a series of excavations in this period. However, amateur archaeologists and local heritage groups remained active in the region, reporting sites to the newly-created State Service for Archaeological Investigations (*Rijksdienst voor Oudheidkundig Bodemonderzoek*). An important achievement of this institute was the creation of protected cultural heritage monuments. In South-Limburg, 63 Roman sites were listed as monuments, 53 of which are classified as villas.[7]

The villa site at Voerendaal was revisited in the 1970s, when new excavations were carried out by the state service. These excavations clearly mirror the influence of New Archaeology. For the first time in The Netherlands the entire villa compound was excavated, rather than just the main dwelling. Attention was given not only to the luxurious house itself, but also to the economic activities that went on within the borders of its compound. The research focus was on the villa as an economic entity that formed part of the Roman market economy. The archaeologists used methods new to archaeology, such as pollen analysis, C-14 and dendro-chronological dating. Unfortunately, a complete account synthesising the results has yet to be published.

The introduction of the so-called 'Valletta Treaty'- archaeological practice in the 1990s led to an explosion of projects carried out in South-Limburg. An analysis published in 2006 of 10 years of archaeological research shows that the number of projects in the region rose from 2 in 1995, to 43 in 2000, to 169 in 2004.[8] One of the most important projects with reference to Roman villas has been the excavation in 2000 of the villa settlement of Kerkrade-Holzkuil by a commercial archaeological company.[9] In a period of nine months the entire villa compound was excavated. Its publication includes several detailed reports by specialists, comprising research topics including paleobotany, ceramics, iron ware, geomorphology, and microscopic analysis of natural stones and tiles. The excavators were able to reconstruct the phasing of the villa, showing its gradual transformation from small-scale single

3 Byvanck 1947.

4 Byvanck 1947, 20: '*Al heeft men zich in Zuid-Limburg al lang intensief met de Romeinsche landhuizen bezig gehouden, er ontbreekt toch nog zeer veel aan de bestudering.*'

5 Clergymen with a special interest in the Roman period.

6 Slofstra 1994, 12

7 Groot 2006, 1, 4.

8 Baere/Mientjes 2006.

9 The *Archeologisch Diensten Centrum* of Amersfoort.

farmhouse to full-blown Roman villa.[10] As of today this remains the only full-scale excavation of a Roman villa in South Limburg that has been published completely.

The 'commercial archaeology' has also resulted in an increase of many small-scale investigations, many of which are done in order to assess the archaeological potential of a specific site.[11] These operations provided important new data for Roman South-Limburg, particularly for elements contemporary with the villas, such as roads, towns, field systems, bridges and farms without any stone structures.

Overall it can be said that, although a great deal of progress has been made over the last 60 years, Byvanck's 1947 assessment still holds true for Roman South-Limburg. Even today it is not known whether the 53 villa monuments are in any way representative of the original settlement pattern. Apart from the main buildings at villa sites, little is known about other aspects of the rural world, such as the average size of the field systems, or the location of farms of a more native character. Virtually nothing is known about the minor local roads connecting settlements and villas to the main road. The abundance of new data generated in the last two decades have not yet been of use in filling these gaps, since the commercial companies are not paid to carry out synthesising research. It seems then that for South-Limburg, the research questions identified in chapter 1 are still unanswered.

It is important to point out that the character of the research has changed over time. Before 1900, no methodological research was carried out whatsoever, as finds were usually made unintentionally. As a scientific discipline, archaeology did not exist; consequently very little theoretical knowledge was available. In the first 5 decades of the 20th century, archaeological research became more intentional, in Limburg at least. More knowledge concerning the interpretation of archaeological material was available. However, nearly all sites in this period were discovered during building activities, and methodological excavations using trained personnel were few and far between. Typically, local publications, such as newspapers and journals, were the information regarding these discoveries were in

After WWII, with the founding of the state service and the developments of archaeology as a discipline, research became more scientific. However, few parties were allowed to execute excavations and small budgets meant limited projects which often were unpublished. In 1997 archaeology in The Netherlands entered the 'Malta-period', in which archaeological research became compulsory during development projects, financed by the initiator of the project. This resulted in more projects, carried out by firms adhering to a specially designed quality system for archaeology, with professionals only.[12] Furthermore, all projects need to be registered and published within two years of the last day of fieldwork.

3.1.2 German Rhineland

For the Roman villa archaeology of the German Rhineland, two recent publications by Kunow provide a good overview.[13] One of the immediate conclusions was that in this part of Germany, military archaeology has dominated from the early days onwards. With major military sites at Cologne, Bonn, Neuss and Xanten, this preference seems only natural, but a consequence of it was that virtually no other aspects of the Roman world have received any attention her, at least not in the decades before WWII. Investigations into civil settlement structures, if any, focused purely on villas, of which only two major sites were excavated in the period before WWII: Blankenheim and Cologne-Müngersdorf.

After WWII, this situation did not really change. There were, however, two notable exceptions in the 1950s: Petrikovits, who studied the Roman rural world in the north of the Eifel[14] and Hinz, who

[10] Tichelman 2005.

[11] So-called '*Inventariserend Veldonderzoek*', done either with none-intrusive methods, with coring or with trial trenches.

[12] The *Kwaliteitsnorm Nederlandse Archeologie*, or K.N.A.

[13] Kunow 1994, Kunow/Wegner 2006.

[14] Petrikovits 1960.

carried out a survey in Kreis Bergheim.[15] Their work shows an interest in reconstructing the Roman settlement system and was clearly influenced by the '*Siedlungsarchäologie*' of Jankuhn[16] from the same era. Petrikovits' work in particular sets out to analyse the entire landscape, including the natural environment. Hinz's work consisted of a '*Landesaufname*' (survey) of the entire municipality of Bergheim, driven by one of the most important factors in Rhineland archaeology: lignite extraction. The triangle of Aachen, Cologne and Mönchen-Gladbach holds Europe's largest deposit of lignite (German 'Braunkohl'). Today, three enormous open-pit mines; Inden, Hambach and Garzweiler, provide fuel for German power plants. These mines are situated in the loam zone between Jülich and Bergheim, (near) the current-day locations of the Roman *vici Juliacum* and *Tiberiacum*. Although lignite had been used as fuel for over a hundred years by the local population, extraction took off in earnest after WWII. Thus, in the German Rhineland, rescue archaeology began some 30 years earlier than in the rest of Europe. Hinz realised that the new plans for extraction in the 1950s meant the potential destruction of vast areas containing important archaeological remains and that measures ought to be taken if archaeologists were to obtain the most basic of information from the region under threat. Consequently he carried out a large-scale survey of the entire municipality, using aerial photographs and field walking to map archaeological phenomena from all periods from the Neolithic to the Middle Ages.

The results, published in 1969, led to an increase of known Roman sites in the area from 11 to 361.[17] Although Kunow challenged some of his outcomes, Hinz's work[18] undoubtedly set a new standard for archaeological research into Roman rural settlement patterns in the Rhineland. His ideas concerning the villa settlement pattern, with different types of villas classified according to their size and type of main building, and the possibilities of centuriation were a clear indication that his aim was not just to map the region, but to analyse and interpret it too. His model of villa settlements alongside the Erft river is proof of this aim.[19]

The next impulse of research into Roman settlement in the hinterland of the German Limes came some 20 years later. It was, once again, provided by lignite extraction, when the Hambach open-pit mine was set in operation in 1978. Due to the fact that the Roman road from Tongres to Cologne ran right across the planned mine, it was decided to focus attention on the Roman period in the archaeological research accompanying this work. Another reason for this was the fact that most of the area had been covered by forest for hundreds of years, augmenting the chance of retrieving well- sites from the Roman period.[20]

The excavations carried out since 1978 by the *Rheinisches Amt für Bodendenkmalpflege,* under the supervision of Gaitzsch, provided a unique opportunity for Roman villa archaeology in the North, namely the chance to excavate an entire Roman villa landscape. By employing different methods of field research, such as field walking, aerial photography and both small- and large-scale excavations a wealth of information concerning the Roman rural settlement system in this part of the Empire has been collected. These techniques have been complemented by modern research methods like dendrochronology and palaeobotany. Subsequently, the results of this research have been published, mostly in the form of excavation reports. The focus in these publications is on the development of the site itself and on what its material culture can reveal about the agricultural, economic, social and religious practices of its inhabitants. Specialist input such as archeo-botanical and zoological research, C-14 and dendrochronological dating and other methods have often been often employed to answer a wider range of issues. However, no attempt has been made yet to use the entire dataset available to produce one coherent reconstruction of the entire Roman villa landscape between the rivers of Rhine and Meuse. Parts of the region have been the subject of work of a synthesising character, such as the main

15 Hinz 1969.

16 See Jankuhn 1977 for an overview of his work.

17 Hinz 1969, 12.

18 Kunow 1994, 151-153.

19 Hinz 1969, 55.

20 Kunow 1994, 154.

buildings of Roman villas in an article by Heimberg,[21] but an all-encompassing study utilizing every contemporary element in the landscape has yet to be undertaken.

It seems then that villa archaeology in the German Rhineland took advantage at every single opportunity when developments took place, whether through large-scale rescue excavations or expanding the research focus beyond the villa compound to Roman settlement patterns and reconstructions of economic activities. Obviously a highly qualitative and quantitative dataset is available for this part of the villa landscape in the North, adding to the urgency for new research that will put it to good use.

3.1.3 BELGIAN LIMBURG

Before WWII, Roman villa archaeology in Belgium concerned itself mainly with the 'rich pickings' of the large villas that abound in its countryside. Belgian archaeologist De Maeyer decided in the 1930s to write a synthesising work on the Roman villas in his country, aiming not only to produce a catalogue of all the known villas so far, but also to analyse 'the spread of Roman culture' in the Belgian territory.[22] This, he claimed, was necessary because of the fact that Roman villa archaeology in Belgium in those days was lacking in methodological research and complete publications.[23] To be sure, apart from a complete overview of all the villa plans excavated so far, his publication contained chapters on the *fundi* (the villa estates), the location and overall pattern of villas and the activities of the villa inhabitants. He even included chapters on the graves of the villa owners (the so-called *tumuli*) and the Roman roads, with maps showing the location of all known villa sites. Three years later he published a catalogue of Roman villas in Belgium, from fully excavated examples to possible villa sites.[24] This publication showed that the majority of villas known in those days were located in provinces other than Limburg, where previously only three villas had been excavated: Schalkhoven (excavated in 1863/1864), Montenaken (same year), and Neerharen/Rekem (excavated in 1885).[25] Although obviously dated in terms of methodology and theoretical framework, his two books remain the only example of a synthesising work on Roman villas in Belgium; looking beyond the main building, towards the other (Roman) elements comprising the villa landscape.

After WWII the Roman archaeologist De Boe conducted several excavations at Roman sites in Limburg and elsewhere, including the villas of Rosmeer and Val-Meer, as well as several *vici* and the well-known villa site of Haccourt in the province of Liège.[26] However, the publications of these excavations rarely had a synthesizing nature and did not extend beyond a basic description of the plan of the main building with a catalogue of associated finds. This can also be said about most Belgium rescue excavation reports on villa and other Roman sites published from the 1980s to the present day, although recent publications do include include chapters on more general research topics. A good example is a recent publication by Van Ossel and Defgnée on the Roman villa of Champion at Hamois, which contains a chapter on general interpretation that addresses issues such as the regional importance of the villa, its agricultural activities, its participation in a market economy and its relationship with the town of Tongres.[27] The Roman archaeology of the town of Tongres presents a case in itself, like Maastricht and Heerlen. Interest in the *civitas* capital of *Atuatuca Tungrorum* led to excavations back in the 19th century, which continue today, under the supervision of a council archaeologist.

21 Heimberg 2002/2003.

22 Maeyer 1937, 14.

23 Maeyer 1937, 15.

24 Maeyer 1940.

25 Maeyer 1940, 37.

26 See for example De Boe 1974, 1975, 1976, 1982, 1984, 1985a and 1985b.

27 Ossel / Defgnée 2001, chapter 6.

It can be concluded then that, similar to The Netherlands and Germany, Roman villa archaeology in Belgium over the last 150 years has provided a large body of empirical data, whose potential for interpretation of social, political and economic aspects has remained largely untapped. The next part of this chapter introduces the process of data acquisition per country, and the quality of the resultant datasets.

3.2 ACQUISITION OF DATA

A landscape-archaeological study such as this requires archaeological and environmental data, and as they differ significantly, the acquisition process for these two types of data will be described separately, starting with the acquisition of archaeological data. It is important to mention at this point that it was the explicit goal of this study to use existing data only, so the acquisition did not entail actual fieldwork or, for example, the interpretation of aerial photographs or satellite images. Another point to stress is the spatial nature of the data used in this study. It is impossible to reconstruct a landscape when it is not known where a particular item was located. This makes the geo-information of each site vital, and lack of good information regarding a particular site could mean that it was not recorded in the database.

In order to reconstruct the Roman landscape as completely as possible a wide variety of sources had to be consulted. For this study, a source could be anything from a modern-day commercial archaeological company, a local volunteer, a priest with a passion for antiquities or a civil servant working for the local council. Equally varied were the research methods from which the data was originally obtained, which ranged from excavation to accidental finds made during building activities. Publication of the data could be two sentences in a newspaper on the one hand, to a 500-pages thesis on the other. The larger the number of sources, the larger the variability in the quality of the data they provide and, related to this, the reliability of the archaeological information, which makes assessing the value of the sources a crucial phase in the acquisition process.

In order to become acquainted with the different sources and research histories of each of the three countries in the study area, it was decided to spend research time in the various parts of the research region. This had the added benefit of getting to know many of the current-day researchers working in the region, ensuring that every available source was located and consulted. It is important to reiterate the goal of the data acquisition, which was to obtain as many sites as possible, however seemingly insignificant. This meant that all possible sources were consulted, including for example the archives of local newspapers and museums, and double checking, with the help of published inventories, whether the resulting dataset was as complete as possible, given the research history of the region.

3.2.1 DATA ACQUISITION IN BELGIAN LIMBURG

Data acquisition for the Belgian part of the research region was carried out at the Gallo-Roman Museum (GRM) in Tongres with the help of provincial archaeologist Mrs. L. Bogaers. The first source that was consulted was the *Centrale Archeologische Inventaris* (central archaeological inventory, or CAI). Archaeological information for sites in the Dutch-speaking part of Belgium is made available by the heritage organisation *Vlaams Instituut voor het Onroerend Erfgoed* (VIOE) through the CAI, which is an online geo-database application. For Belgian Limburg the information in the CAI was created by individual researchers, the GRM and local volunteers. Each site in the CAI provides information concerning the location, the archaeological activity, the researcher, the results, and references to publications. A single (central) xy-value is given for each site, as well as an indication of the reliability of that information. When a site cannot be located within a range of 250 m accuracy, it is not given an

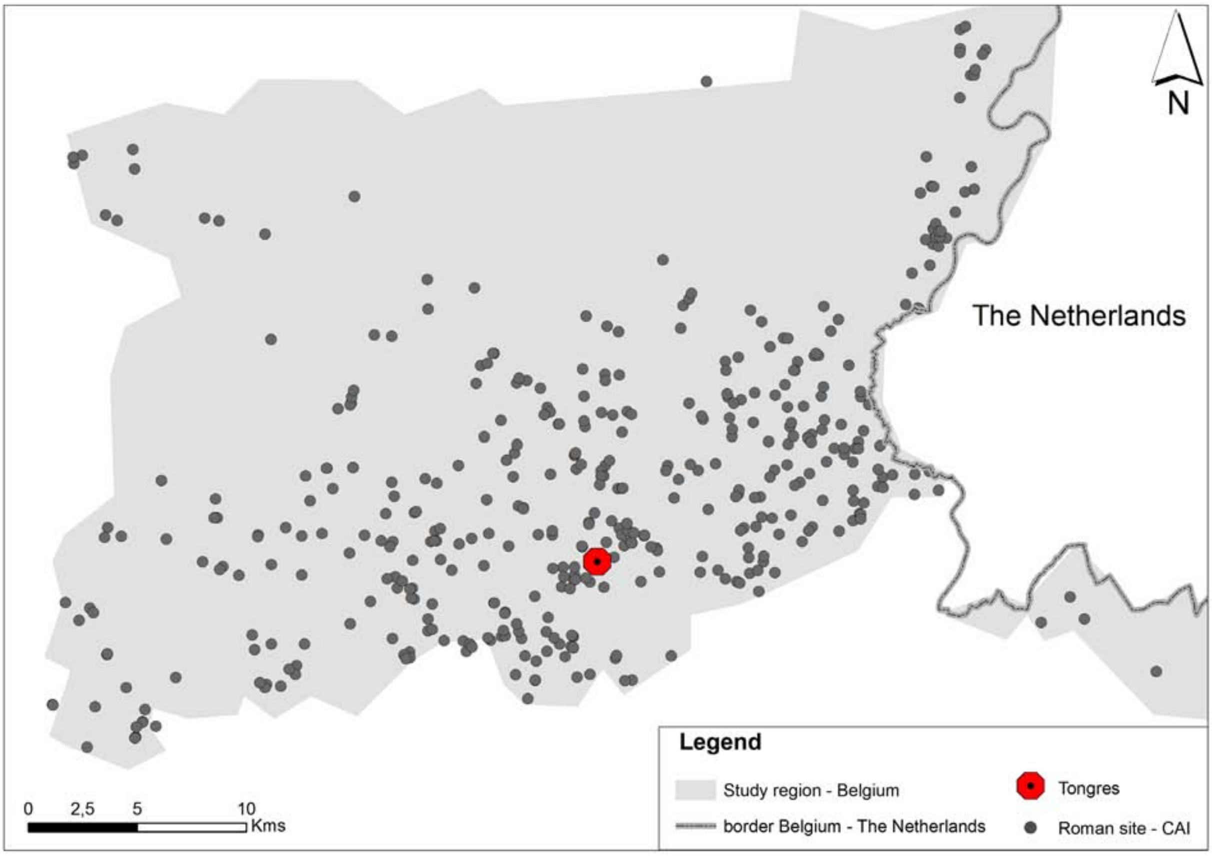


Fig. 3.1 Map showing the distribution of sites in the Belgian part of the study area, based on the CAI data.

xy-coordinate. The actual spatial information from the original documentation is provided, which enables the researcher to evaluate the location given by CAI to the site. The archaeological information is copied from the original documentation, including the interpretation of the site and the data; in most cases the actual find material is also described. Figure 3.1 shows the distribution of the 466 sites taken from the CAI.

In addition to the CAI, the archives of the GRM were explored for sites that were not (yet) recorded in the CAI. The 1:10.000 maps of the province of Belgian Limburg that are kept at the GRM proved to be valuable in this respect, as previous members of the GRM's staff had indicated sites containing Roman material on them, based on personal observations or information provided by another party. Furthermore, relevant literature and Belgian archaeological journals were consulted.[28] A valuable source was the different archaeological inventories that were published over the years. The oldest inventory, by R. de Maeyer dates back to 1940 and, as such, forms the first Belgian attempt to provide a national synthesis of Roman sites since the middle of the 19th century.[29] In retrospect, this

[28] Annaert 1994, Breuer 1944, De Boe 1966, De Boe 1974, De Boe De Boe 1975, De Boe 1976, De Boe 1979, De Boe 1980, De Boe 1982, De Boe 1984a, De Boe 1984b, De Boe 1984c, De Boe 1987, De Boe 1984, Claassen 1987, Corbiau 1997, Cuyt 1983, Deschieter 2003, Dethier 1977, Hackens 1985, Ibens 1976, Impe 1983, Impe 1984, Jessup 1970, Jessup 1973, Jessup 1974, Leman 1980, Maeyer 1937, Maeyer 1940, Marien 1980, Mertens 1964, Mertens 1985, Moitrieux 2005, Nouwen 1997, Pauwels/Verhoeven/Vynckier 2000, Raepsaet 1995, Scollar 1958, Vanderhoeven / Vynckier 1991, Vanderhoeven / Vynckier 1992, Vanderhoeven 1992, Vanderhoeven 1996, Vanderhoeven / Creemers 2000, Vanderhoeven et al. 2006, Vanvinckenroye 1988, Vanvinckenroye 1990, Vanvinckenroye 1994, Vanvinckenroye 1997, Vermeulen / Antrop 2001.

[29] De Maeyer 1940.

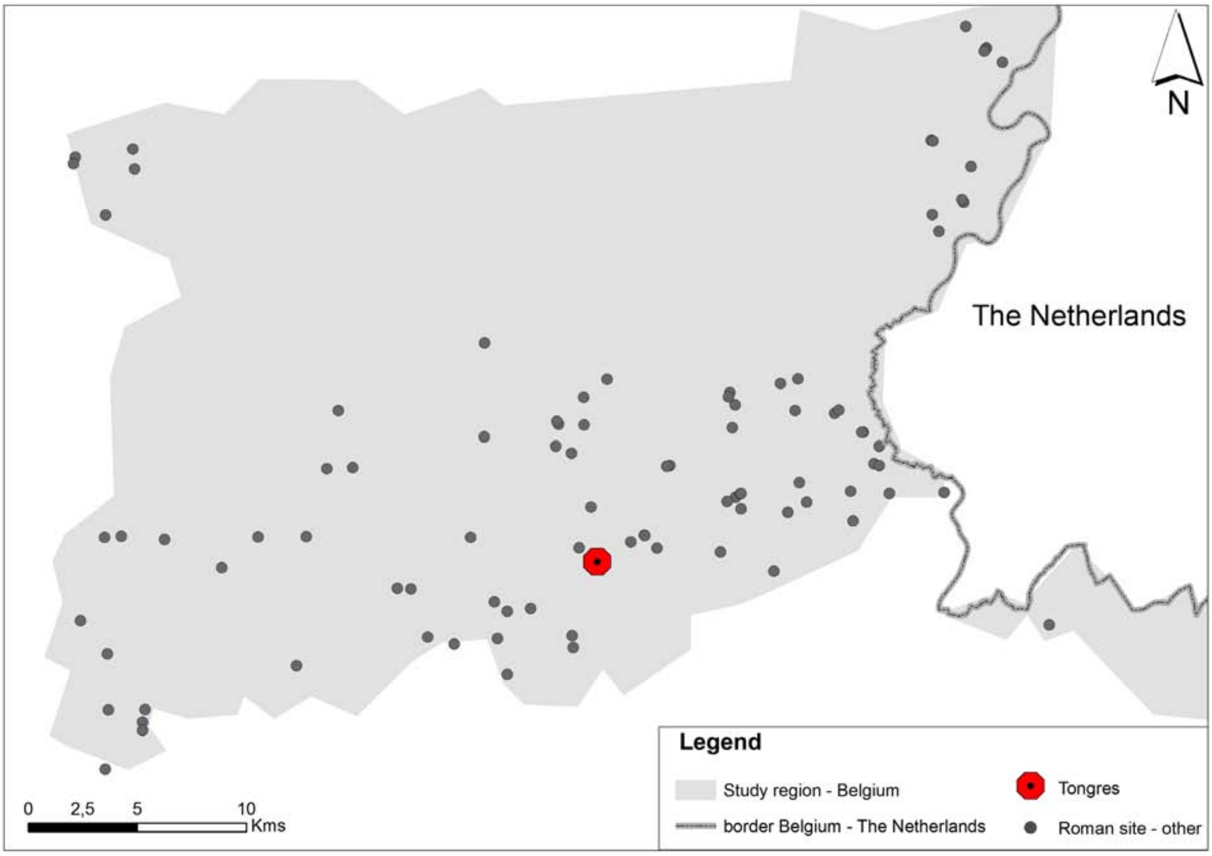


Fig. 3.2 Map showing the distribution of sites in the Belgian part of the study area, based on sources other than the CAI.

period formed the heyday of Roman villa research in Belgium. Its chapter on the history of archaeology in Belgium gives insight into the origins of the Roman dataset, showing how, in the early days, all focus was on the extensive main buildings of villa settlements, excavated predominantly in the central and southern regions of Belgium. The next inventory did not appear until 1971.[30] The author concluded that at the time there were still many gaps in knowledge concerning Roman villas in Belgium. Interestingly, the most recent inventory work has been carried out by students in unpublished theses, such as the ones by Robberechts[31] and Duurland.[32] The work by Robberechts, for example, contains an extensive catalogue with information on the source, location and the archaeological material per site. Duurland actually carried out several field surveys to check the location of previously identified sites, while in the process adding a number of new sites. Although these sources provide a wealth of information concerning Roman remains in the region, unfortunately detailed spatial information is sparse. Sometimes only a general description of the find location is provided, and the maps are on such a small scale that it is impossible to ascertain exactly where the site is located. These problems notwithstanding, it was possible to create a second dataset of sites based on these sources that resulted in the addition of 105 sites.

Overall, the data acquisition for Belgian Limburg did not pose major problems, and it can be concluded that the resultant dataset is a reliable representation of the archaeological activities carried out there over the last 150 years. Whether the resultant dataset properly reflects the actual situation in Roman times is another issue that will be further discussed in chapter 5.

30 De Boe 1971.

31 Robberechts 1998.

32 Duurland 2000.

For the dataset concerning Roman Dutch Limburg, the starting point was Archis2, an online geo-database set up and managed by the '*Rijksdienst voor het Cultureel Erfgoed*', the national organisation for cultural heritage of the Netherlands. Archis2 was designed for registered members of the archaeological community in the Netherlands. It is used to register every archaeological activity on Dutch territory, making it the most reliable source for the results of current-day 'commercial archaeology'. As such, a site can be represented in Archis2 by several entries, each consisting of a particular archaeological activity. Each entry provides information about the type of archaeological activity, the archaeologist, details of the find material, and references to publications. For the classification of the site, a national system has been developed by the *Rijksdienst*, called the archaeological basic register, or ABR; the person performing the data entry has to choose from this classification system when characterizing the site. In total 607 sites were mapped based on the information provided by Archis2.[33]

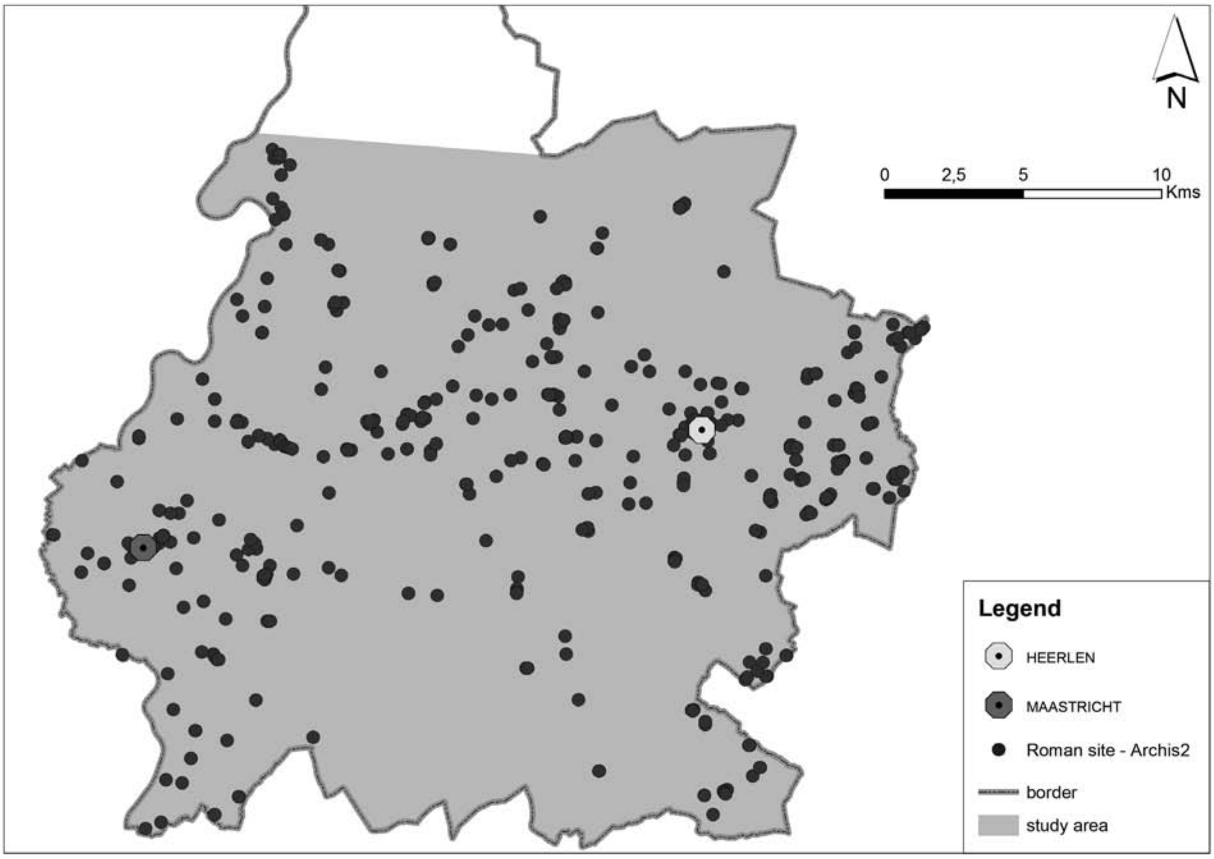


Fig. 3.3 Map showing the distribution of sites in the Dutch part of the study area, based on Archis2.

For results concerning the period prior to 1995, Archis2 is a good starting point, as it also contains the archaeological data from the *Rijksdienst* itself. This was collected since the foundation in 1948 of the *Rijksdienst voor het Oudheidkundig Bodemonderzoek* (ROB), the former State Service for Archaeology and the predecessor of the current-day *Rijksdienst voor het Cultureel Erfgoed*. Many of the archaeological activities carried out in Dutch Limburg in the period 1948 – 1995 were carried out by the *Rijkdsdienst* and for the results of these activities Archis2 is the best source. In the course of the first year of data

[33] Based on the Archis2 dataset of 2007.

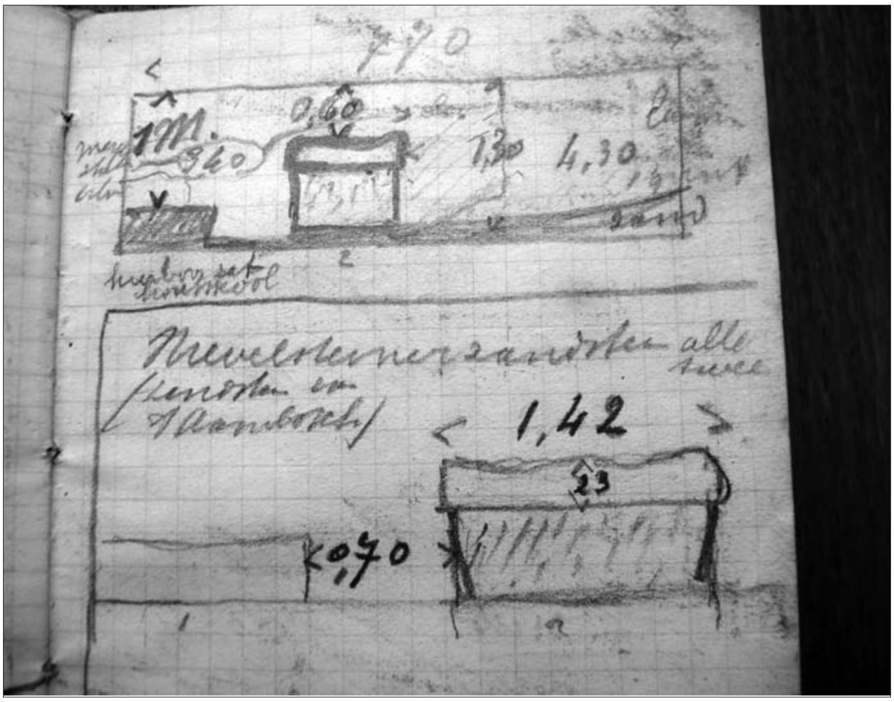


Fig 3.4 Example of a page from the field notebook from Goossens, with details concerning an incinerary urn. Source: RHCL, LGOG collection Goossens

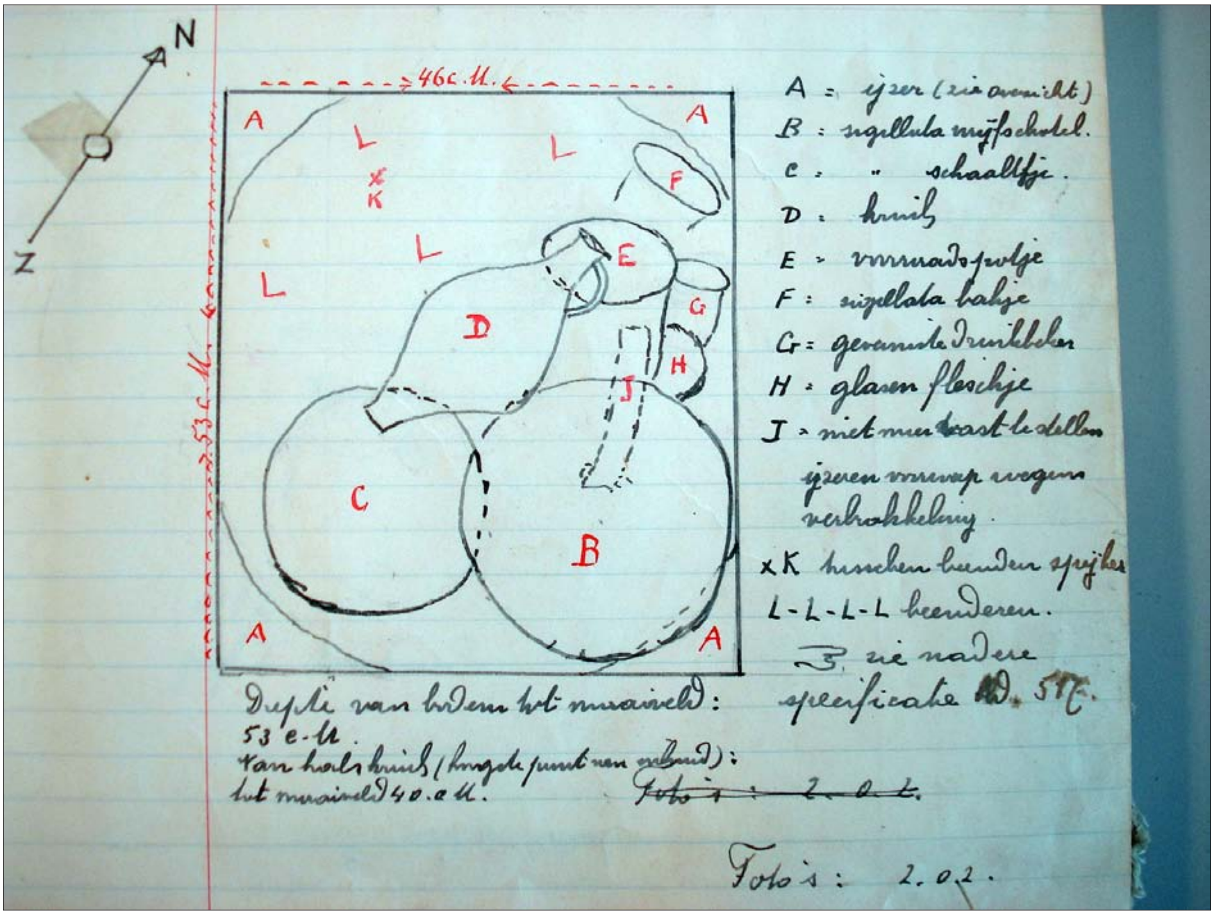


Fig 3.5 Example of an entry by E. Nijst in the LGOG register regarding the contents of a grave. Source: LGOG register.

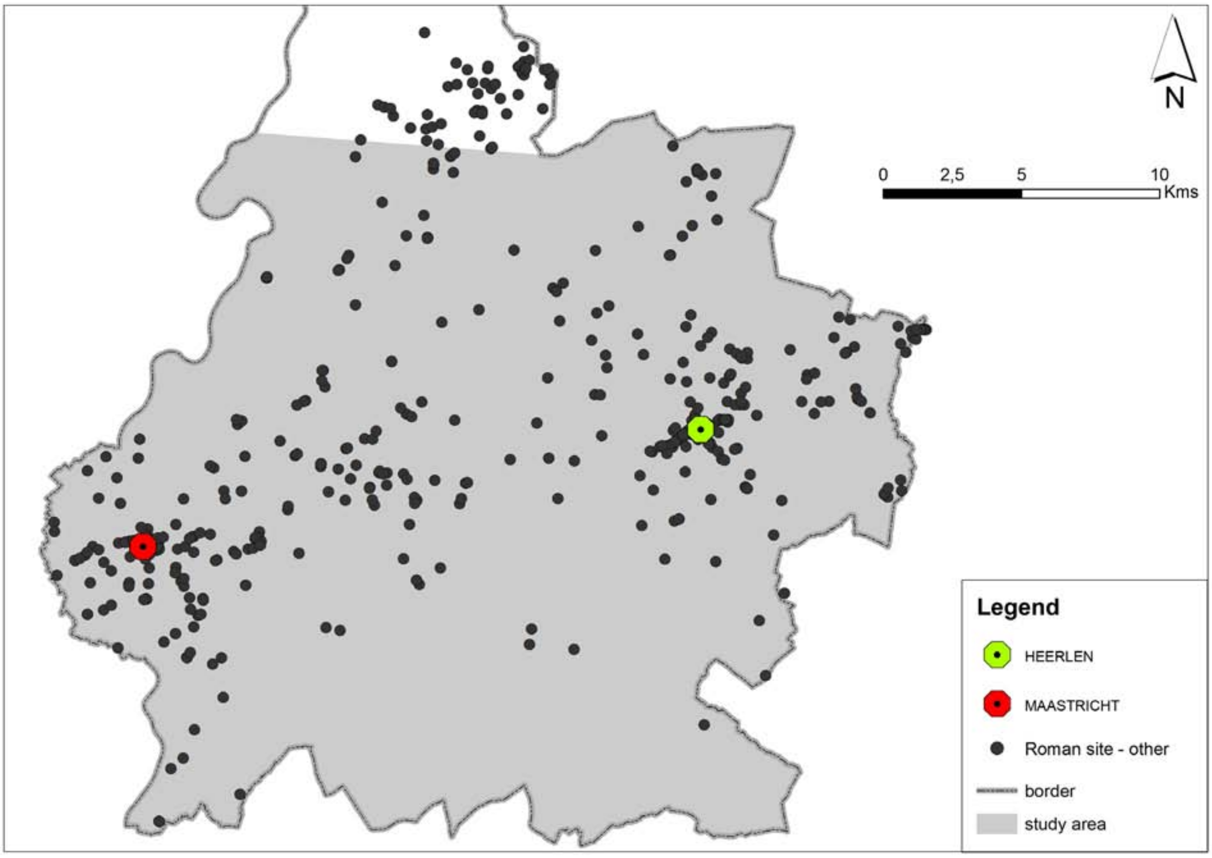


Fig. 3.6 Map showing the distribution of sites in the Dutch part of the study area, based on sources other than Archis2.

acquisition, however, it became clear that many Roman sites in South-Limburg are not registered in the RCE database. This is especially true for sites discovered in the period prior to 1950. Frantic building activities took place in the mining region in southeast Limburg in this period, resulting in many accidental discoveries of Roman remains. The consultation of alternative sources did not only result in additional sites, but also allowed for the correction of the location of sites known from Archis2, due to detailed descriptions and drawings of the find-spot.

In the *Regionaal Historisch Centrum Limburg* (Regional Historical Centre of Limburg), in Maastricht, the LGOG archive was consulted, as well as the collections of Goossens and Habets. As described in chapter 3.1, Goossens and Habets were key players in the Roman archaeology of the region in the period prior to 1940. Both can said to have had a fastidious character, which is evident from their legacies. Goossens in particular seemed to have kept every piece of relevant paperwork, including his field notebooks, newspaper clippings and correspondence, all of which is available in his personal file at the RHCL.

The LGOG kept a register of the material in its possession and this also proved to be a valuable source of information. The examination of the handwritten register, currently part of the LGOG collection at the *Centre Ceramique* in Maastricht, was written by E. Nijst in the period 1930 – 1940. This source in particular provided important details concerning known and unknown sites. Nijst worked as an assistant to Goossens, but when the latter became immobile due to poor health, he took it upon himself to inspect new discoveries at the location where they were found. His descriptions and drawings of both the find material and its find-spot are very detailed, as can be seen in figure 3.5.

In Heerlen, the former *vicus* of *Coriovallum*, the archives of the former *Gemeentelijk Oudheidkundig Dienst* (Council Service of Antiquities) of the town was examined. These archives, located at the *Ther-*

men (Roman bath) Museum, provided information regarding a century of archaeological activities in the southeast of Dutch Limburg. As noted earlier, in this particular region coal mining was a booming business from the end of the 19th century all through the 1970s, when the mines were eventually closed. Large-scale developments related to this industry unearthed many sites, and the details concerning many of them are found in the council archives, kept at the museum in Heerlen. In addition to these sources, the entire collection of archaeological journals from Limburg was consulted,[34] as well as several key overviews of Roman finds from before 1950. These inventories of the earliest period of Roman archaeology in the region were useful to check the completeness of the dataset. Furthermore, literature considered relevant for data information was studied.[35] Last, but not least, several people were interviewed, both professional archaeologists and experienced volunteers living in the region. [36]

During the time of data collection in Dutch Limburg several councils, such as Maastricht, Valkenburg, and Gulpen-Wittem, were in the process of commissioning so-called 'archaeological policy maps' for commercial companies. In most cases, the inventories carried out by these companies could be consulted. The archaeological departments of the towns of Maastricht and Sittard permitted the use of the complete datasets for the Roman sites found within their town's boundaries, based on these inventories.[37]

Acquisition of archaeological data for South-Limburg required more time and effort than the other two countries. In particular the consultation of sources other than Archis2 was a time-consuming process. Nonetheless, it was time well spent, as 388 sites were added to the 607 sites from Archis2. The datasets obtained from the council archaeologists at Maastricht and Sittard resulted in the addition of 155 and 62 sites respectively. The time spent researching the South-Limburg region afforded the author a thorough understanding of the archaeological history of the region. This included developments in public space since 1850, such as changing land use, and destruction of traditional landscapes. This knowledge turned out to be vital to the interpretation of the resulting dataset.

34 These are the *Publications de la Société Historique et Archéologique dans le Limbourg*, the *Maasgouw*, and the *Land van Herle* journals.

35 Batta et al 1976, Beckers 1940, Byvanck 1943, Byvanck 1947a, Byvanck 1947b, Bloemers 1967, Bloemers 1973a, Bloemers 1973b, Bloemers 1975a, Bloemers 1975b, Bloemers 1977, Bogaers 1874, Braat 1934, Braat 1948, Braat 1953, Braat 1964, Brounen 1989, Caumartin 1867, Datema 2004, Daemen 1965, Debunne/Dauzenberg/Kluijving 2002, Demey 2003, Derks 1989, Dijk 2006, Dijkstra 1997, Engelen 1984, Felder 1964, Felder 1968, Felder 1969, Felder 1973, Franzen 1988, Gaauw 1994, Geelen 1961, Goossens 1908, Goossens 1912, Goossens 1916, Goossens 1918a, Goossens 1918b, Goossens 1922, Goossens 1923, Goossens 1930, Goossens 1931, Goudswaard 1994, Graaf 1986, Graaf 1988, Graaf 1989, Groenendijk, H., Groot 2005, Groot 2006a, Groot 2006b, Grooth 1989, Grooth 1997, Haaff 1993, Habets 1865, Habets 1866, Habets 1867, Habets 1868, Habets 1871a, Habets 1871b, Habets 1878a, Habets 1878b, Habets 1881a, Habets 1881b, Habets 1881c, Habets 1882, Habets 1885, Holwerda / Goossens 1907, Holwerda 1916, Holwerda 1918, Holwerda 1924, Holwerda 1931, Hommerich 1949, Hontem 1986, Hontem 1990, Hulst/Dijkman 2000, Hupperetz 1991, Isings 1971, Jamar 1986, Jamar 1989, Janssen 1865, Janssen 1865, Janssen 1866, Keijers 2003, Kempen 2000, Kolen 1993, Nillesen 1988, Otter 2007, Panhuysen 1984, Panhuysen 1993, Panhuysen/Dijkman/Hulst 1996, Peters 1921, Peters 1922, Peters 1926, Peters 1927, Peters 1934, Polman 1999, Polman 2000, Polman 2001, Remouchamps 1922, Remouchamps 1923, Remouchamps 1925, Renes 1988, Schuermans 1867a, Schuermans 1867b, Stoepker 1988a, Stoepker 1988b, Stoepker 1988c, Stoepker 1993, Stoepker 2006, Tichelman 2005, Vanneste 2006, Vin 1985, Vries 1999, Vroman 2004, Willems 1983, Willems 1985, Willems 1986, Willems 1986a, Willems 1986b, Willems 1987, Willems/Kooistra 1987, Willems 1988a, Willems 1988b, Zinn 1997.

36 See appendix 1 for a complete overview of the people interviewed.

37 The author would like to thank G. Soeters and M. Aarts for making these datasets available.

The German part of the research region lies in the province of Nordrhein-Westfalen. The administration and management of archaeological activities in this area, and the resulting data, is carried out by the '*Ambt für Bodendenkmalpflege im Rheinland*' (ABR), which is part of the '*Landschaftsverband Rheinland*' (LVR). The database of the ABR is not available to consult online, so data acquisition was carried out at one of the offices of the ABR, located at Titz-Höllen. This *Außenstelle* (outpost) lies in the middle of the lignite-extraction area, fieldwork at the three open-pit mining areas, Hambach, Weisweiler and Frimmersdorf, is coordinated from here and, as a result, this is where the documentation and finds material is stored. Three months were spent here acquiring data for this part of the study area, during which the archive of the *Außenstelle* was thoroughly examined. Advice and additional information was given by the researchers at Titz-Höllen, in particular Dr. W. Gaitzsch.

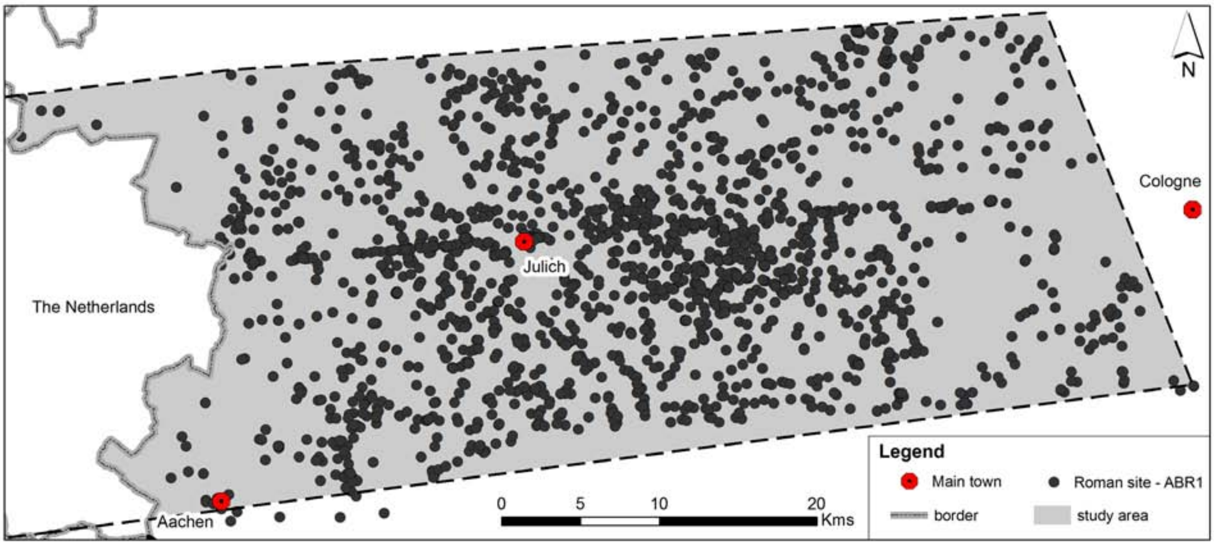


Fig. 3.7 Map showing the distribution of sites in the German part of the study area, based on the ABR general dataset (ABR1).

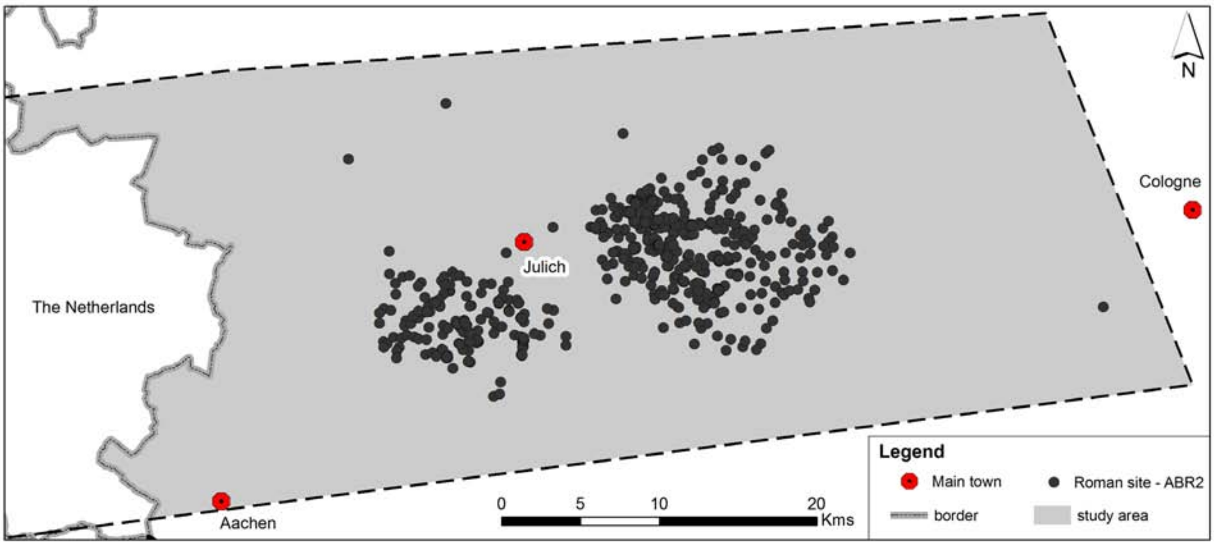


Fig. 3.8 Map showing the distribution of sites in the German part of the study area, based on the information in the archives at Titz-Höllen (ABR2).

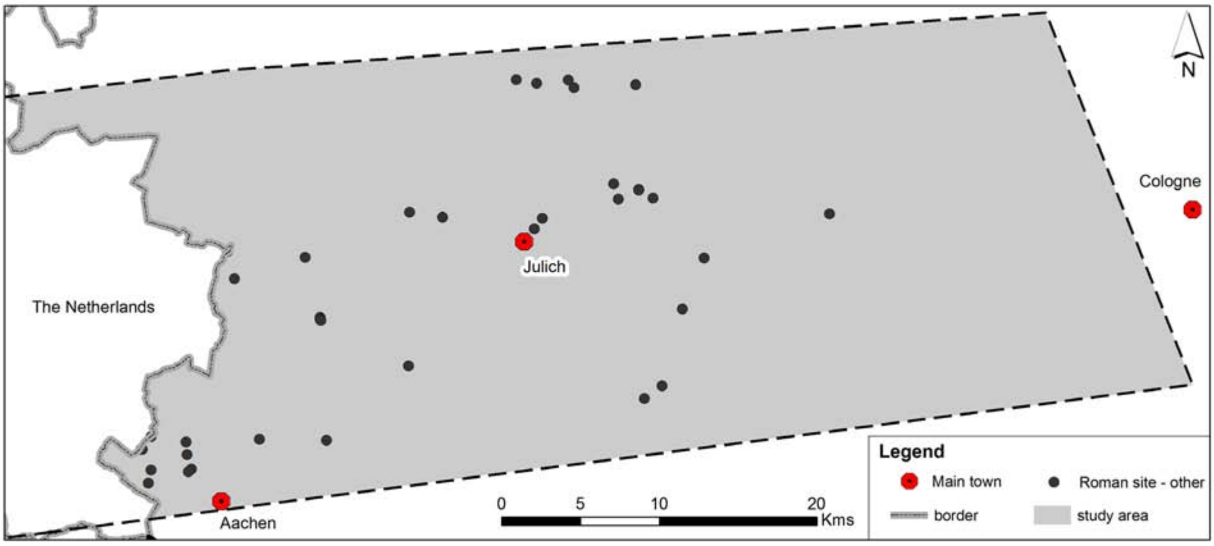


Fig. 3.9 Map showing the distribution of sites in the German part of the study area, obtained from sources other than the ABR database and archives.

The ABR-database is comparable to Archis2 as it provides a point location per archaeological activity, with further information concerning the type of research, the researcher, the location, and the find material. There is a special field for the accuracy of the location. Under '*Typ*' one of the different interpretative labels is chosen; under '*Funde*' the actual material found can be registered. There are separate datasets per category of which the main are *Siedlung* (settlement), *Graber* (burials), and *Verkehr* (transport). With the information from the ABR database a dataset of 2328 sites was created.

A second source for this region was the archive of the ABR outpost at Titz-Höllen, consisting of the original field documentation, such as drawings and reports. Every archaeological activity is recorded on a standardised form, and the inspection of these forms often provided additional information concerning Roman sites in the area. Additional information was gathered by studying relevant literature.[38] As a result, a second dataset was created, called ABR2, containing 623 sites, most of which were located in the Hambach and Weisweiler areas. Special attention was given here to excavated sites. In most cases an ABR-excavation of a Roman settlement in this region is not limited to the main building, but includes the surrounding structures, ditches, burials and, in some cases, even the road leading to the settlement. In order to record as many details as possible, including the spatial layout of Roman rural settlements, as many plans as possible were scanned and geo-referenced. The dataset for the lignite mining area therefore contains both point locations and polygons.

Apart from the work at the archive at Titz-Höllen, several other sources were consulted for this study. Journals like the *Bonner Jahrbücher* were explored for additional information on Roman sites, especially the early editions. The council archaeologists at Aachen and Jülich were interviewed, both of whom provided important information concerning these two Roman towns. Local volunteers in the Aachen – Vaals region generously offered their knowledge of Roman archaeology in the area.[39] Combined, this information resulted in a third dataset for the German part of the study area, consisting of 43 sites. Most of these are in the 'border zone' between the Dutch territory and the lignite-mining area.

38 Andrikopoulou-Strack et al. 1999, Andrikopoulou-Strack et al. 2000, Andrikopoulou-Strack 2001, Andrikopoulou-Strack 2007, Bender 1994, Gaitzsch 1983, Gaitzsch 1986, Gaitzsch 1990, Gaitzsch 1991, Gaitzsch 1993, Gaitzsch 2004, Gaitzsch 2008, Gechter / Kunow 1986, Heimberg 2003, Hinz 1969, Horn 1987, Koschik 2004, Kunow 1994, Kunow 2006, Lenz 1998, Lenz 1999, Petrikovits 1960, Wendt 2008.

39 See appendix 1 for an overview of the people interviewed.

Although the data acquisition for the German part of the study area was a daunting task, as the area measures over 1600 square kilometres, the results are worth the effort because of the quantitative and the qualitative aspects of the resulting dataset. The nature of the archaeological practices in this area means the dataset can be considered the most complete of the entire study region. It provides important spatial information that can be used to reconstruct the rural settlement landscape, as will be shown in chapter 5.

3.2.4 Sources of environmental information

The environmental data used in this study was obtained through different channels. For Dutch Limburg, digital data for soils, elevation, and hydrology were obtained from researchers at the University of Wageningen who had worked on a publication on the environment, commissioned by the government of Limburg.[40] At Tongeren this type of data was provided by the provincial government through the staff at the Gallo-Roman museum, and at Titz-Höllen digital maps for water and soils were obtained by the ABR organisation.[41] In order to create an elevation model for the entire study area use was made of the ASTER[42] Global Digital Elevation Model, which was released on June 29, 2009.[43]

3.2.5 Complications

When consulting the various sources two important issues were encountered. The first concerns the relation between database entry and archaeological site. As was noted above, each of the databases consulted organise their information based on archaeological activities. This is demonstrated by figure 3.10. The map shows the distribution of seven entries in the Archis2 database. Each entry represents an archaeological activity, carried out between 1936 and 1988. From a cultural heritage management viewpoint this makes sense. But it means that an entry in the database does not necessarily translate into an individual site. The seven entries in figure 3.10 represent a single settlement, namely the Roman villa settlement of Kaalheide Krichelberg. This issue will be addressed further in chapter 5.

The second issue relates to the characterisation of a site. Each source applies its own system of site classification. In most cases the classification is done by the person carrying out the archaeological activity, but in many cases the material is reclassified, the digitisation of hand written records by most national or regional cultural heritage organisations being a case in point. Not surprisingly this results in diversity in finds material characterisation and site classification. How this issue was dealt with in this study will be explained in the next part of this chapter.

The last issue concerns the reliability of information. The diversity in personnel and archaeological activities obviously influences the reliability of the information, whereby a distinction needs to be made between the reliability of spatial information and that of archaeological information. A source can provide highly reliable information on the archaeological remains found, but fail to give unambiguous directions concerning the whereabouts of the site and vice versa. In chapter 3.3 this issue will be discussed further.

[40] Kerkstra, Vrijlandt, Jong and Houwen 2007.

[41] The researcher wishes to thank the organisations mentioned for providing the data.

[42] ASTER stands for Advanced Spaceborne Thermal Emission and Reflection Radiometer.

[43] Websites: http://asterweb.jpl.nasa.gov/gdem.asp; https://wist.echo.nasa.gov/wist-bin/api/ims.cgi?mode=MAINSCCH&JS=1

3.3 STORING AND VISUALIZING DATA: THE GEO-DATABASE

Data storage may seem a straightforward process of copying the information as provided by the source, but as indicated in the previous section, there are various complications that must be dealt with in order to obtain a homogeneous and reliable dataset. Before addressing these complications, the actual construction of the geo-database will be introduced. Only issues relevant to this study are discussed; general information on how to build a (geo-)database is left to experts on the subject.

The main goal of the data storage process is to construct a homogeneous dataset that is versatile enough to allow a wide variety of analyses. Homogeneity is guaranteed by designing the database in such a way that it ensures the registration of the same attributes for each item; flexibility is ensured by adding different attribute fields.

The actual process entails the storage of information in a specifically designed geo-database. Each item to be registered in the database consists of three components:[44]

1. geometric information: details concerning its location (in most cases the central coordinate of the find-spot), and, where possible, its dimensions;
2. attribute information: its non-geometric characteristics, which can be anything from information concerning the type of archaeological activity to the description of the find material;
3. temporal information: reference to a specific time, which in this study meant a date within the Roman period.

The geo-database of this study was made in ArcView.[45] It consisted of three feature class datasets, one for each of the three countries comprised in the study area. This was imperative because each country has its own projected coordinate system.[46] Data could thus be stored according to the original spatial address. In a later stage a fourth feature class dataset was created with a projected coordinate system applicable to the entire research area, in this case UTM 31, and the data of the three 'national' feature class datasets exported to the new overall dataset.

Each feature class dataset consists of feature classes. These can be seen as individual databases, storing data in any number of fields. Each item in a feature class has a spatial address, connecting the information to a specific location within the chosen projected coordinate system. The strength of any GIS system lies in the potential of combining different datasets;[47] there is no limit to the number of feature classes that can be added to one dataset, or to the type of information stored. It can be a 'ready-to-use' dataset obtained from a source, such as a raster dataset for soils that, when seen in ArcView with ArcMap, shows the distribution of different types of soils within a certain region. On the other hand, a researcher can design a feature class with attributes according to the needs of the project. The attributes for the non-geometric and non-temporal information can contain any type of data; numeral or text. As pointed out earlier, the main goal in this phase was to produce a homogeneous dataset. When deciding on the feature classes that have to be created for the entire research region, it was therefore imperative that they contained the same attributes as their 'neighbouring' feature classes, in other words to ensure *integrity of attributes*. The geo-database enforces this integrity through domains and validation rules. An 'attribute domain' is a specified set or range of valid attributes formulated by the researcher.[48] When a domain is created in a geo-database, it can be used for any feature class, thereby ensuring storage of identical information in the different feature class datasets. For the storage of basic information concerning the Roman landscape, domains were formulated for fields such as 'type of research', 'dating', 'identity', 'reliability of archaeological information' and 'reliability of spa-

[44] Kraak/Ormeling 2003, 3.

[45] By Environmental Systems Research Institute (ESRI), Inc.

[46] For Belgium this is the Lambert 1972 system; for The Netherlands the Rijksdriehoekstelsel Amersfoort (RD new) system, and for Germany Gauss-Kruger zone 2.

[47] Kraak/Ormeling 2003, 8.

[48] Zeiler 1999, 12.

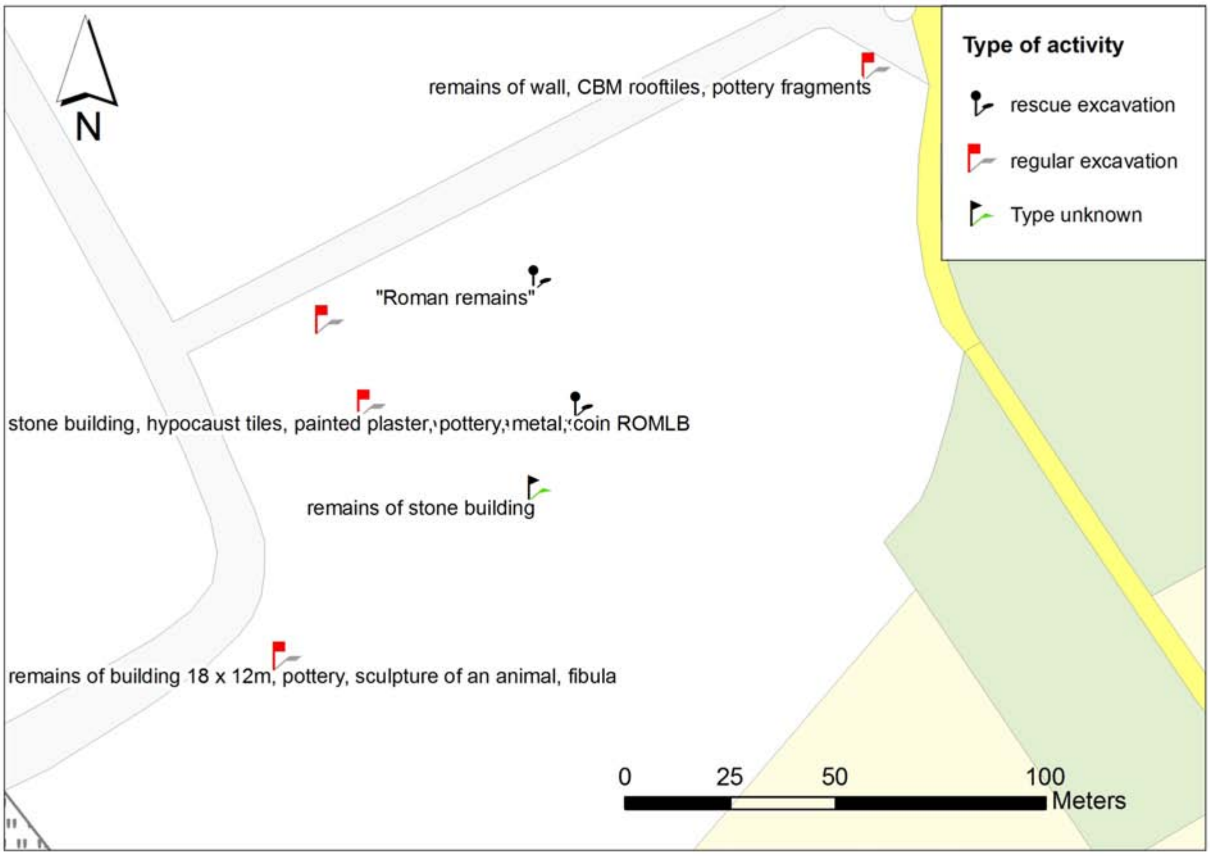


Fig. 3.10 Map of the distribution of seven entries from Archis 2 at Kaalheide – Krichelberg in Dutch Limburg.

tial information'. At the beginning of the data storage process it was decided to copy the sources in as much detail as possible to prevent loss of information. Once the information was copied, new feature classes were then created, based on the 'basic dataset'.

attribute domain	valid attributes
type of research	excavation trial trench archaeological observation during building activities observation (general) coring metal detector field prospection aerial prospection salvage excavation

Tab. 3.1 The attribute domain for the data entry field 'Type of research' and the chosen attributes.

Below, the process of data acquisition and storage will be discussed. As this process was performed per country, its description will be presented the same way, starting with Dutch Limburg. However, firstly, the topic of data visualisation will be discussed.

3.3.1 DATA VISUALISATION

The visualisation of spatial data is seen by many archaeologists as an unproblematic and straightforward step in data processing. As spatial data is best communicated by means of a map, most archaeologists present their data in the form of distribution maps. Archaeological finds are represented by a chosen

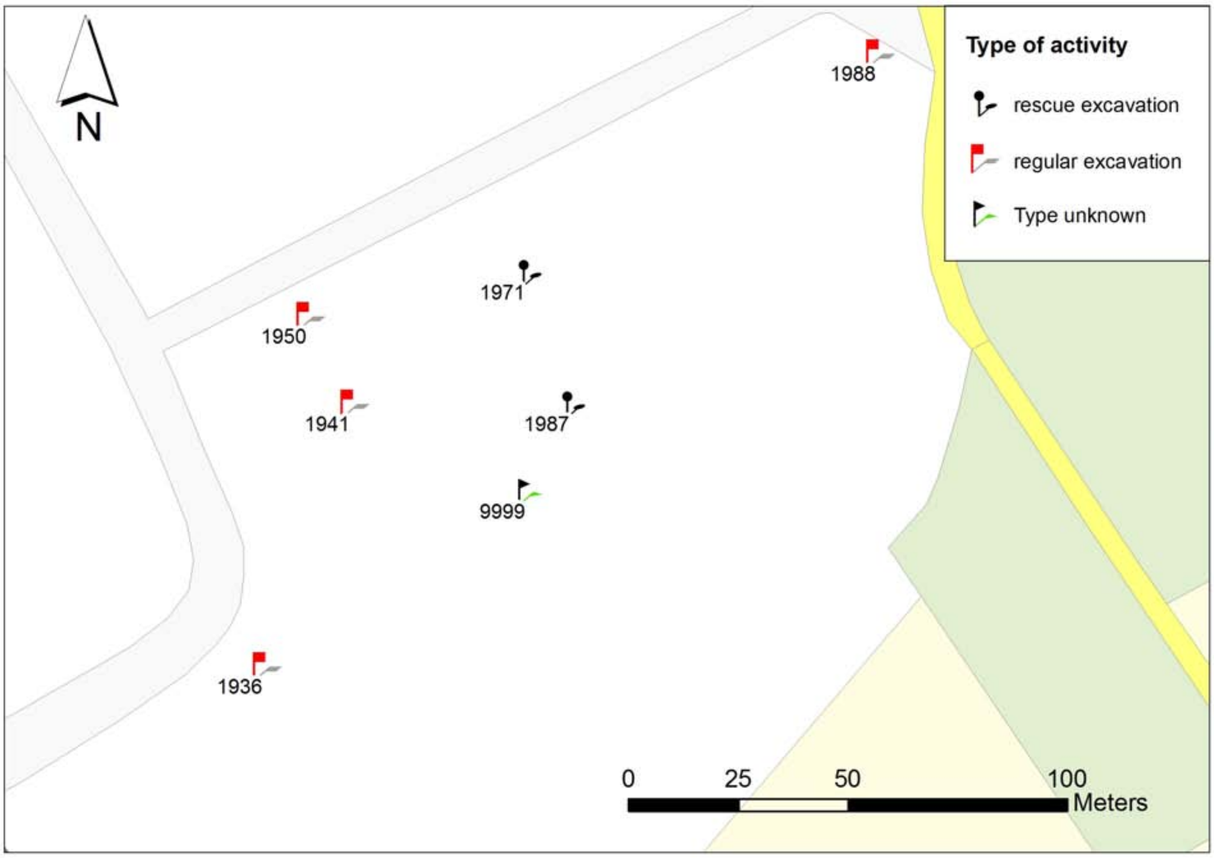


Fig. 3.11 This map shows how each archaeological activity comes with its own centre coordinate, depending on the location examined at that particular moment.

symbology against the background of, either environmental, or topographical, information, such as waterways, relief or the current topography. Many publications lack references to the arguments underpinning the chosen visualisation. However, there are many complex problems related to the visualisation of data, of which most archaeologists seem to be unaware. One of the reasons why archaeologists seem unconcerned by these problems, is that many depend on mapping specialists to produce maps for them. Often the archaeologist delivers the data to a specialist, trained in the visualisation process, who then produces the desired map. In addition, software offering easy to use mapping tools are now readily available. As cartographers have pointed out, however, the developments in geo-ICT over the last 25 years have had important repercussions for the production and use of geospatial data, one of which is the observation that 'maps are no longer just the final products they used to be'.[49] Researchers can use the additional possibilities provided by a GIS to explore their dataset and produce intermediate analysis results that support the entire research process, in addition to making maps to present final results.[50]

In this study, visualisation of data was done both during data acquisition and data storage, with each of the three tasks complementing each other. In fact the data storage itself often made use of the visualisation technology of the GIS, as for example when the item in question came with unclear information concerning its whereabouts, which was often the case with the older data.

49 Kraak / Ormeling 2003,1.

50 Kraak / Ormeling 2003, 1.

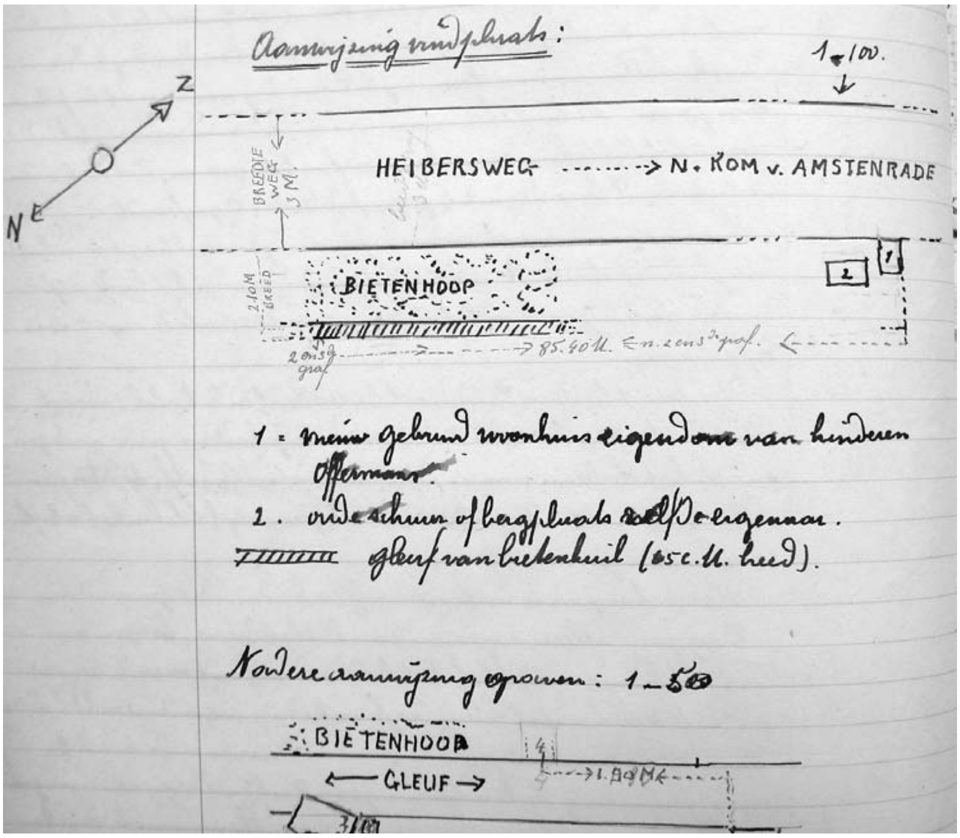


Fig. 3.12 Example of detailed information for a particular site in the Dutch part of the study area, described by E. Nijst, proving that researchers from the period prior to the 1940s provided good quality spatial information. The find-spot is marked in metres from identifiable elements in the landscape such as a road (*Heibersweg*), a heap of beets (*bietenhoop*) and buildings (a house and a barn, indicated by the numbers 1 and 2). Source: LGOG register, Centre Ceramique, Maastricht.

Many of the sources from the period prior to 1950 described locations based on the topography of the time. Geo-referenced historic maps, such as the '*Bonnekaarten*' for Dutch Limburg, helped to locate many sites from the early period. In other cases, use of a digital elevation model could help to locate a find-spot, for example when specific information concerning its location was given, such as '*at the foot of the hill*'. Visualising find-spots during data storage had the added bonus of being able to verify whether the given xy-coordinates corresponded with the information provided by the researcher. In some cases this led to the correction of the location of items. This will be discussed further in the next part.

3.3.2 RELIABILITY OF INFORMATION

During the first stages of data storage several issues arose, the most important of which concerned the reliability of information. It became clear that the information from some sources was much less reliable than that of others. As the goal of this study was to make a landscape reconstruction, information concerning the reliability was seen as a vital attribute of the items in the dataset. It would allow decisions in the reconstruction process of whether or not to include an item in the reconstruction, and how to characterise it. Therefore it was decided to introduce a way of recording the reliability of the information to the dataset. Unfortunately, as an awareness of this issue arose during the process of data

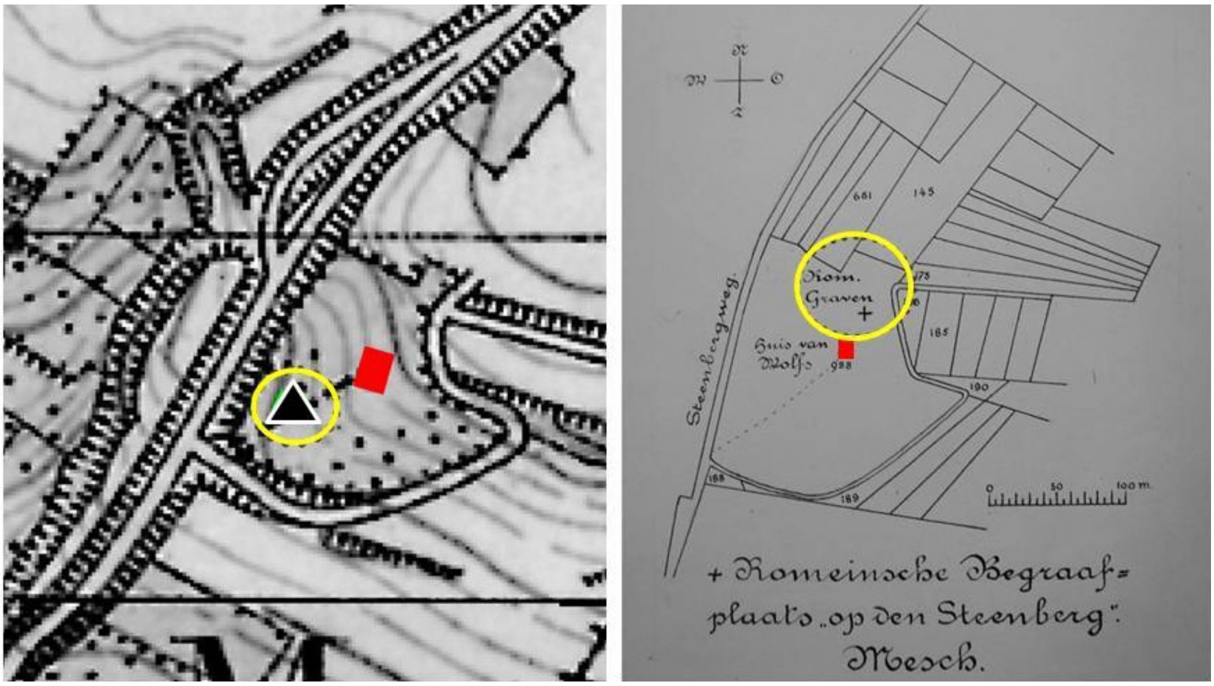


Fig. 3.13 The map on the left shows the location of burials (black triangle) southwest of the farmhouse (square) as provided by Archis2. On the right a map drawn by Goossens indicates the find-spot of the burials (+ sign) to the northeast of the farmhouse. Sources: Bonnekaarten (left); LGOG archive Goossens, RHCL Maastricht (right).

storage, it has not been recorded uniformly for the entire dataset. However, the issue was addressed in some form of another for each of the items registered in the database. For example, in cases where there was doubt as to the validity of information, this was added to the 'remark' field.

It also became clear that it was important to distinguish between the spatial information of a data item and the archaeological information, which will be explained below. It should be stressed that the reliability discussed below concerns that of an individual find-spot. The cumulative effect of different archaeological activities performed over a number of years can result in highly reliable information about a site, even when individual acts might be less reliable.

Reliability of spatial information

The reliability of spatial information discussed here relates to data concerning the location of the archaeological phenomena found, as provided by the source. For example, in the form of a topographic map, a description or (an) xy-coordinate(s). It does not refer to the *accuracy* of the location of a particular item in the Roman landscape, which is a different thing altogether, as will be explained now. Because of the landscape scale, all elements are represented by points, meaning that the different items in the Roman landscape are represented by single points in space. Because the intention is to reconstruct the landscape as completely as possible, an item can be anything from a single coin, or a scatter of surface finds, to a completely excavated house plan. It is assumed that the spatial information provided by the source, often in the form of an xy-coordinate, indicates the centre of the area where the material was found; hence the given coordinate is called the 'centre coordinate'.

However, it is debatable what the given 'centre coordinate' stands for and whether it is the same point in space that would be chosen by another researcher. For example, is the centre of a villa settlement the centre of the main house, the centre of the farmyard around the main house or the centre of the entire estate including the farm land? Is the centre of a burial site an individual grave that happened to be seen during building activities, the middle of an entire burial field, or the centre of only a part of the burial field that happened to be excavated?

In most of the study area, the current-day practice of archaeology means that site size is determined by the building activities it precedes, rather than the (assumed) extent of the archaeological feature. To add to the problem, the nature of the archaeological activity often influences the determination of the centre of the site, for example a field survey will provide a different centre coordinate than an excavation. It becomes even more complicated when multiple archaeological actions have taken place within a particular area, each being given different centre coordinates, as shown in figure 3.11.

Another aspect to consider is the question of methodology. It obviously matters considerably whether a centre coordinate is determined by an archaeologist using a portable GPS or by looking at a map; whether it was chosen by someone to whom the find was reported by someone else, or awarded by the person performing the task of digitizing old records. These examples only hint at the diversity concerning the ways a specific 'point on the map' for archaeological phenomena can be chosen, making it inevitable that the information provided always harbours a certain degree of inaccuracy. It is impossible to prevent the fact that the actual centre of an item in the database may well not coincide with the point indicated by the source. But this does not have to be a problem as long as it is taken into account whilst performing spatial analyses. In fact the CAI and ABR geo-databases give information regarding the (estimated) accuracy of the chosen xy-coordinate of an item. This can be used as an indication of the reliability of the spatial information. For example, when the accuracy is less than 250 meters, it basically communicates the message "*we don't really know where this was found, but it must be somewhere in this area*". The CAI geo-database is quite strict in this respect, as it does not give any coordinates to a site when the accuracy cannot be given within a 250m range. This does mean, though, that the site itself cannot be incorporated into a geo-database. The ABR-database has the attribute field '*Genauigkeit*'[51], where an estimated accuracy is provided (<200m, <20m); in addition it mentions the source of the information from which the estimation was made, such as '*coordinates in the publication*', '*sketch on copy of map*' or '*measured exactly*'. Unfortunately Archis2 or the ABR-database do not provide this kind of information.[52]

To conclude, the factors that were found to influence the reliability of the spatial information as defined in this study area are:

- the methodology used to determine the location
- the researcher or individual entering the information
- the location information given by the source
- the year of research
- the type of research

The cumulative effect of these factors often plays an important role, meaning each item in the geo-database needs to be assessed individually. However, some generalisations can be made. Typically, modern-day excavations using GPS-technology, or older excavations, executed by meticulous researchers, providing detailed plans with topographical information can result in highly reliable spatial information. Results of field survey and coring often provide less accurate centre coordinates, especially as few of these are published with detailed maps showing concentrations of find material.[53] Often, volunteers with a good knowledge of the local topography can provide more reliable information than archaeologists new to the region. When it is unclear what method was used and who performed it, often the centre coordinate of a site may be unreliable. Nevertheless, only when the information provided was such that the site could not be located at all (for example, '*in the garden of mister X*') was it decided to reject a site. Interestingly, there does not seem to be a direct relationship

51 Translation: accuracy

52 Apparently the first version of the RCE geodatabase did provide estimates of accuracy of location; however Archis2, which is the second version, no longer shows this information.

53 This refers to the situation in the study area.

between the date of the archaeological activity and the reliability of the spatial information. As was stated earlier, many of the early researchers were meticulous in their documentation of sites, including their location, often providing detailed maps of the site and its surroundings (for example, see fig. 3.12). With the help of digitised topographic maps based on hand-drawn originals from the 1920s, the majority of items from the period prior to the 1940s could be located.

In some cases the information in the original documentation consulted for the Dutch data could even be used to correct the location of an item provided by Archis2, as shown in figure 3.13. It is important to remember that when geo-databases like Archis2 and the CAI were set up, large amounts of pre-existing data had to be digitised. It was unavoidable that mistakes were made during this process, especially in the absence of accurate spatial information such as plans or detailed descriptions of the find location, or of tools to locate these sites, such as old cadastre maps.

The reliability of the spatial information (i.e. the centre coordinate used to map the item) was taken into account for the creation of the dataset presented in chapter 4 and the reconstruction of the settlement landscape introduced in chapter 5.

Reliability of archaeological information

The reliability of the archaeological information can be as uncertain as that of the spatial content. This is to be expected when dealing with the results of 150 years of archaeology in three different countries, particularly due to the variety in the group of researchers. Incorporating as many items as possible meant dealing with this variety, and it was therefore important to address the issue in one way or another during the recording of sites in the database. As with spatial information, the reliability of this type of information is determined by several factors: the researcher, the period, the method of research and the information itself. Again, there are no strict guidelines for determining whether the information is highly reliable, less reliable or even unreliable, as the cumulative effect of the individual factors varies considerably, making it imperative that each individual item is judged on its own merit.

The individual providing the information is an important aspect, as it can be anyone from an academically trained professional to an anonymous individual who happened to notice finds during building activities. One would assume that the information provided by a trained professional is always more reliable than by an untrained person, but this is not always the case, especially when the individual is a local volunteer with years of experience in the region. It is therefore important to identify those sources that provide reliable information in a specific area, and it proves once again how important it is for the researcher to familiarise themselves with local research histories and its protagonists.

Equally important is the period in which the archaeological information was generated. Since the middle of the 19th century there have been numerous important developments in every aspect of the archaeological field. Again, this does not automatically mean that information from the 'early days' is less reliable than that of recent years; there are many instances where the detailed description of finds, so characteristic of the earliest period of research, result in much higher reliability of the archaeological information of a site than that of a hastily performed modern 'salvage operation'. In other respects, though, the information of early 20th century excavations cannot match those of large-scale modern excavations using modern equipment, and technologies such as dendrochronology and C-14 dating, and the theoretical frameworks concerning the Roman era and the natural environment.

The methods used to obtain the archaeological information is the third factor contributing to its reliability. In general, methods generating the most detailed information are excavations and trial trenches. Field surveys, remote and ground sensing techniques and metal detecting also provide good information, but often require additional research in order to classify a site. Coincidental finds *in situ*, observations during building activities, historical sources, hearsay, and finds *ex situ* generally provide archaeological information with less reliability. As with spatial information, the reliability of the archaeological information was taken into account during the reconstruction phase of the study.

3.3.3 DATA STORAGE

For the Dutch data a feature class dataset was created using ArcView, with the national grid *Rijksdriekhoekstelsel New* as the designated projected coordinate system. When starting with the data storage, nine feature classes (separate datasets within the feature class dataset) were made, following the system of categorisation in Archis2:

1. settlement sites
2. burial sites
3. cult sites
4. waterworks
5. industrial sites
6. bridges
7. military sites
8. mines & quarries
9. roadways

The feature classes 1 to 8 contained point-data; the feature class 9 ('roadways') contained line data. An additional feature class regarding protected heritage sites in the region containing polygon data was obtained directly from the *Rijksdienst voor het Cultureel Erfgoed*. The spatial information provided by Archis2 in the form of a (central) xy-coordinate was used to create items in the relevant feature class. For each new item the following attributes had to be registered:

- location (town, address)
- Archis-number
- year of research
- name researcher
- type of research (domain)
- dating (domain)
- find material

It was decided to record the actual find material as objectively as possible. For example, when a source described the material found at a site registered as a 'cult site', the find material itself (limestone foundations) and its dimensions (square, 4x4m) were recorded, along with any artefacts. This proved to be an important step, as will be explained later.

Source research in the different archives in Limburg resulted in an additional dataset of considerable size. In order to store this information a new feature class was created, '*Non-Archis*', in order to be able to distinguish these items from the dataset obtained from Archis 2. It contained the same attributes, plus an additional field for 'identity'. The datasets for the Roman remains found within the city boundaries of Maastricht and Sittard were obtained in the form of a ready-to-use shape files.

For Belgian Limburg the process of copying the information from the CAI database was straightforward, as in almost all cases the number of point locations per item was one. The search for additional sources took little time, as the GRM-archive at Tongres was used for the setup of the CAI database, and therefore contained limited additional information. A new feature class dataset was created with the Belgian Lambert 1972 coordinate system. The CAI information was then copied in newly made feature classes for settlement, burial, economic and transportation evidence. As the data storage was done in Tongres, it was possible to discuss specific sites with the staff at the museum, which helped to judge the reliability of the information and the completeness of the resulting dataset.

When comparing the information provided by the CAI to that of Archis2, it became clear that the two datasets were not identical. It also became clear that instead of several feature classes representing different categories of archaeological evidence, a single feature class, presenting the entire range, was far more user-friendly. Therefore it was decided to add a new feature class to the dataset, with the name 'data-def', with a total of seven attributes:

1. identity
2. dating
3. reliability of archaeological information
4. reliability of spatial information
5. type of research
6. period of research
7. description of find material

Although the attribute 'identity' does require a certain amount of interpretation of the find material, it was added to give a broad indication of 'what was found'. There were 25 labels to choose from, ranging from coin to *civitas* capital, and from storage building to small find.

For the German part of the research region a copy of the geo-database of the *Ambt f*ür *Bodendenkmalpflege Rheinland* was obtained. The setup of this database is such that it can be used in the same way as the datasets for the Dutch and Belgian territories. It provides information concerning reliability of location, researcher, type of research, and material found. The data is organised in categories, the main ones being settlement, burial and traffic. These were converted into feature classes and added to the feature class dataset set up for the German data. The information obtained from council archaeologists and local volunteers was put in a separate feature class. The majority of these points are located in the area east of the border with Dutch Limburg. This dataset contained the same seven attributes of the feature class created for the Belgian area. Another feature class was created for the storage of the data generated from the *'Abbaugebiete'* (mining areas). Although the ABR-geo-database covers the results of the archaeological research in this area, archive work at the outpost in Titz-Hollen resulted in additional, highly detailed information. Therefore, it was decided to create a special feature class to store the additional data. With the new feature class, large areas of the Roman rural landscape can be reconstructed in detail, including the spatial layout of individual settlements. This proved to be an important step, as will be shown in chapters 4 and 5. It had the additional benefit of providing insight into the problem mentioned earlier of the central coordinate of a site, by showing the position of each element found in comparison to the centre.

3.4 DATA CLASSIFICATION

In the phase of data storage and subsequent visualisation informed decisions have to be made regarding the characterisation of items in the dataset. Apart from the issues addressed earlier in this chapter, there is variance in the use of specific archaeological terms for certain features, such as villa, *tumulus* or road. The problem with these terms is that their meaning has become diffuse, as they have been in use for over 150 years, and, as a result, what is seen as what, by whom, varies considerably. For example, the term 'villa' is used for many different find material complexes, from completely excavated settlements with boundary ditches, burials and several auxiliary buildings, to scatters of ceramics and roof tile fragments detected through field walking. In addition, the cumulative effect of many years of archaeological activity means that material found and classified at different moments in time can, at present, be interpreted as a single material assemblage. This can potentially lead to a different classification. For example, a single coin can, in hindsight, be attributed to a settlement that was excavated years later. This means that a decision had to be made whether to visualise every single item ever found in the region, or whether to construct a specific system for data classification and apply this to the dataset before presenting it as 'the' dataset of the study area. It is an important decision, as it influences the subsequent phases of landscape reconstruction and analysis, and potentially limits the type of research questions that can be answered. As was outlined in chapter 1, in order to progress beyond the mere descriptive, and arrive at the level of a profound analysis of the landscape based on the research questions, it is imperative that the data is classified so that the resulting dataset is capable of providing answers.

To tackle the problems mentioned above, a system with four elementswas created. The first element is a set of specific types of find material. This set is necessary for the second element, which is a set of site types. The third element relates to different levels of data interpretation, and the fourth element represents spatial guidelines for interpretation. It is believed that, together, these four elements will ensure a homogeneous dataset capable of producing reliable analyses and allowing for inter-regional comparisons. It is also hoped that they will eradicate any bias due to differences in the nature of archaeological activities, or the era in which a site was found and interpreted. The four elements of the system will now be introduced.

3.4.1 DEFINING MATERIAL EVIDENCE CATEGORIES IN THE ROMAN LANDSCAPE

Each archaeological interpretation starts with an analysis of the actual find material. If the goal is to construct a homogeneous dataset, it goes without saying that use of a particular data classification, for example 'main road', is the result of the presence of (a) certain type(s) of find material. When assessing the items in the attribute field 'find material', a number of reoccurring types of material evidence can be identified, characteristic of the Roman archaeology in the region. Once these types are categorised, criteria can be defined for each of the chosen types. Of course it is important to choose material evidence that, when analysed, can provide answers to the research questions, for example with regard to different types of settlements, burial practices, or economic activities.

The nine categories of material evidence chosen for this study are:

	CATEGORY	EXAMPLES
1	natural stone - building material	roughly hewn blocks of limestone, sandstone, silex
2	Roman concrete products	mortar, plaster, *testa contuse*
3	ceramic building materials	rooftiles, *tegulae, tubuli*
4	ground features	postholes, ditches, pits
5	earth works	mounds, banks, and ditches
6	remotely sensed features	cropmarks
7	human remains	cremation burial, inhumation burial
8	remains of perishable goods	leather, textile, plant and animal material
9	miscellaneous artefacts ceramics metal objects glass objects natural stone used as household objects	 wheel- or handmade: *terra sigillata*, amphorae fibulae, coins, ornaments, nails, keys, *militaria* vessels, beads, bracelets *mortaria*, quern stones

Tab. 3.2 The nine categories of material evidence defined in this study.

Category 1 is usually found *in situ* in the form of remains of a built complex such as a wall, but can also be found as loose artefacts scattered on the surface. In the study area different types of natural stone, such as limestone, silex, sandstone and volcanic rock from the Eifel region were used as building materials, for houses, burial monuments, roads, and objects such as *stèles*. This category can be retrieved by means of almost any type of archaeological activity, even indirectly through crop-marks and ground sensing. Because it is non-perishable and easily recognizable, natural stone has a high degree of detection.

Category 2, concrete, is a key element of Roman architecture and, as such, is a good indicator of Roman sites. It can take the form of mortar or plaster. Like natural stone, it is non-perishable and highly recognisable and therefore has a high degree of detection.

Category 3 refers to another type of find material commonly associated with Roman architecture, ceramic building materials such as *tegulae* and *tubuli*. Again, this is a non-perishable, highly recognizable and detectable category.

Category 4 comprises of ground features, basically pits and ditches of different shapes and sizes, recognizable through coloration of the soil due to post-depositional processes. They can be postholes, wells, graves, or robbed foundation trenches. Most ground features are detectable only by means of excavation, therefore this category has a much lower degree of detection than categories 1, 2 and 3. The fact that ground marks are notoriously difficult to recognise in loess soils aggravates this problem.

Category 5 is made up of various forms of earth works, which can be seen as elevations or depressions in today's landscape. They are the result of either deliberate actions in the past (building a grave mound, digging a ditch for drainage), or of post-depositional processes (equalizing of elevations by ploughing). Such earth works are often well-known landmarks, and they can sometimes be identified through toponomic research.[54] These elevations and depressions can also be detected by means of high-quality LIDAR (laser altimeter) data.

Another type of archaeological evidence that can be detected with remote and ground sensing techniques is category 6. Aerial and satellite imaging is used to detect crop and soil marks, while ground sensing techniques, such as ground penetrating radar and magnetometry, produce images of archaeological remains beneath the surface.

Category 7 refers to the remains of a human body, either cremated or inhumated.

Category 8 comprises the remains of all other non-human organic materials, such as leather, animal bones, pollen and wood. Human remains are in most cases found in some sort of container, usually a ceramic vessel, making this category highly recognisable, even for the untrained eye. Although animal bones are easy to spot too, pollen and other organic materials require the meticulous excavation of features such as wells or pits. In any case, organic material from the Roman period is very seldom preserved in the loess soils. It is therefore rare to find items of this category in the study area.

Artefacts from the 8 categories mentioned above cannot be reliably dated as 'Roman' when found just by themselves. Therefore it was decided to identify category 9 as a vital dating instrument. This category comprises of artefacts made from a range of material, including ceramics, metal, glass, and natural stone.

3.4.2 DEFINING SITE TYPES AND LEVELS OF INTERPRETATION

With the main find material categories defined, the next step was to design a particular typology of sites, the choices in which had to be the result of a deliberate appraisal of the archaeological information, preferably taking into account the variability caused by researchers and their methods on the one hand, and the research questions on the other.

An important point of departure concerns the macro-regional scale of this project: with an average scale of 1:150,000, settlements, for example, are represented by point locations. This influences

[54] For example, the word '*tumulus*' can be seen in many current-day toponyms, such as '*tomveld*'. The *tumulus* itself might be gone, but the surviving toponym indicates the existence of a barrow.

the type of sites that can be represented on the maps. At a landscape-scale, the mapping of individual houses within a small town does not make sense. Secondly, the resultant dataset should be suitable for further reconstructions, meaning the chosen typology needs to represent the archaeological information as closely as possible whilst still producing an intelligible map.

A closely related issue concerns the level of interpretation. It can be argued that in some cases all that is needed is a map of 'Roman sites', with no further need for identification of the remains. However, data characterisation becomes necessary if questions regarding the landscape, for example regarding demography and economy, are to be answered. The challenge, therefore, was to come up with a set of labels and corresponding symbology that would result in a comprehensible map of the Roman landscape, whilst also allowing further questioning and interpretation. This challenge was met by introducing three levels of interpretation, used in combination with the chosen typology. The levels were as follows:

I. At level 1 no further characterisation was done apart from that of 'Roman site'. This level was used to obtain general insights in the overall dataset.
II. At this level of data characterisation a site was assigned to one of five main categories that were considered to be relevant to the Roman villa world, i.e. where new insights were to be expected when analysing these categories. These were:
   a) settlement evidence
   b) burial evidence
   c) road network evidence
   d) evidence of specialist economic activity
   e) evidence of specific Roman features
III. The highest level of interpretation implied the characterisation of sites as subtypes of the five dimensions of level II.

As an example, a site can be characterized as a 'Roman site' at level I, as 'burial evidence' at level II, and as a 'large stone incinerary urn' at level III. Circumstances dictate the level chosen to characterise and visualise the data. In addition to the five categories, a sixth category, 'indefinable evidence', was designed. This indicated sites that did not fit the guidelines defined in this study for any of the five categories at level II.

The advantage of the use of levels of interpretation for the categories of site types is that they enable the incorporation of a wide range of sites, including those of less detailed information, those obtained by different archaeological activities, and even those for which the sources are not as reliable. Excavated evidence can be combined with field survey results at level 2, whilst analysing evidence at level 3, for example, provides insight into the distribution of particular types of settlement or burials.

An important point of departure was the incorporation of current knowledge of Roman features, both within the region, and in other parts of the empire. With the wealth of completely excavated sites in and outside the study area it was possible to construct a classification system with clear guidelines for the corresponding material evidence. This was then used for sites obtained through other, non-invasive methods of research. Of course the information generated in the other two studies within the Roman villa landscapes research project was incorporated in the system, for example the classification system for villa settlements in the study by Habermehl.[55]

With the typology in place, minimum criteria regarding the actual find material were formulated. This meant identifying those combinations of finds that could, with certainty, be said to represent a specific type of evidence. This way the homogeneous interpretation of the entire dataset and uniform visualisation of the research region was ensured. These criteria will now be presented, for the five chosen categories at levels II and III of interpretation.

55 Habermehl 2011.

A. Settlement evidence

Settlements and settlement patterns are a key subject in most archaeological landscape studies. Settlement evidence is therefore the most frequently-used categorisation. Often sites are awarded the characterisation 'settlement' when specific types of find material, such as burial remains, or evidence of specific artisanal activities, are lacking.

For this study, the challenge was to formulate guidelines that would be flexible enough to capture the entire range of Roman settlement types present in the study area, based on find material complexes obtained through both invasive and non-invasive field techniques. The requirements for a site to be characterised as 'settlement' was set at a minimum of two types of evidence, depending on the nature of the material found. For example, when an aerial photograph shows the layout of a rectangular house and examination of the site on the ground resulted in pottery fragments, the evidence together was seen as sufficient for the characterisation of the site as a settlement. Pottery fragments together with roof tile fragments, a common combination of find materials in the study area, were not considered as conclusive evidence of a settlement and thus classified as 'indefinable evidence' (category 6 at level II). Pottery fragments, roof tile fragments and fragments of stone used as building material, however, was seen as sufficient evidence to interpret the site as a settlement.

Choosing the subtypes in the category of settlement evidence proved to be an additional challenge, in particular when it came to characterising the different types of rural settlement in the region. Obviously the chosen subtypes determine the information that can be obtained through analysis. But in the study area this happens to be one of the key research issues, that of the Roman villa.

Traditionally, Roman rural settlement in the region is characterised as either a villa or as a 'native / non-villa farm' and it would seem logical to use the same distinctions to present the settlement evidence. But it was decided nonetheless to look for a slightly different characterisation. As pointed out in chapter 1, the term villa has, over the years, acquired many different meanings, although there are certain points on which there is general consensus, at least regarding the material evidence. The term is used to describe a rural settlement consisting of several buildings, concentrated within a certain area, surrounded by fields, pastures and woodland. Typically, in the built area one building stands out, because of its size (usually the largest) and because of the use of Roman building materials, such as natural stone for the foundations, ceramic building material such as roof tiles, and the presence of particular architectural elements, such as a hypocaust and a *porticus*. This building is usually considered as the main house, where the family of the landowner is thought to have resided. The other structures within the built area are seen as either the dwellings of farm workers, or as stables, sheds, or workshops. However, in the past the main building alone was seen as 'the villa'. In fact, in almost all cases the villas excavated in the period prior to the 1950s were actually excavations of the main house only. In a modern sense, the term villa can only be undisputedly used when proven by large-scale excavations of, at least, the entire built area, meaning the main house and the other buildings.

Conversely, the term non-villa has been taken to mean a rural settlement characterized by houses made only with perishable material, such as wood and thatch, and built according to 'native' traditions. Generally this means four to six large central posts that held up the roof structure, a thatch roof and walls of wattle and daub. In the study area rural non-villa settlements usually comprise of a few contemporary houses. Conclusive evidence for this type of settlement can only be obtained by means of an excavation, which means that in a region where non-invasive archaeological activities outnumber the invasive activities, the number of 'non-villa' settlements can be expected to be disproportionally low.[56]

Although I do not question the validity of the interpretation of sites as a villa or a 'non-villa / native farm' settlement, I am of the opinion that these terms are of limited use for the reconstruction

[56] See chapter 5 in this study for further elaboration of the issue.

of a landscape in a region where sites that are discovered by non-invasive methods largely outnumber the number of sites that are excavated, and where the majority of excavation at sites has only been partial. More importantly however, if the purpose of this study is to map in detail the entire range of settlements within the research area, it is believed that the use of the traditional terms like 'villa' and 'native farm' will essentially prevent any new insights into the composition of the settlement landscape. Evaluation of the sources has furthermore shown that the term villa has been all too readily applied in the past because of its 'popularity', making many of these interpretations if not unreliable, at least somewhat suspect.

The challenge then is to come up with terms that do justice to the variability of Roman settlement forms, rural and urban, that can also be applied to the results obtained from methods other than excavation. This would allow an homogeneous interpretation of the entire dataset in the category 'settlement', and ultimately enable the reconstruction of the complete settlement landscape with its potential diversity.

Today, many scholars use a range of factors for the characterisation of settlement, such as the size,[57] layout,[58] or the less commonly used occupation of a site or its symbolic dimension.[59] The advantage of this flexibility in data characterisation is that it allows for the incorporation of sites resulting from both invasive and non-invasive methods. This means that, rather than focusing on the more traditional settlement types like 'villa' and 'native farm', settlements are characterised based on the information available. As shown by for example Nuniger,[60] simply recording the different categories of material evidence can help to map the settlement landscape in all of its nuances, allowing for the discovery of settlements that would not be 'seen' using the traditional terms of villa / farm.

As pointed out in chapter 1, the resulting dataset must be able to answer the research questions regarding settlement dispersion and nucleation, continuity and change, and the questions of status, architecture, and the spatial organisation of rural settlement. I have, therefore, chosen to use building material as the main distinguishing factor in the characterisation of rural settlement. It makes sense to use a typology that reflects one of the most dramatic changes in house building, that is also highly visible archaeologically, without having to use the terms of 'villa' and 'native farm'. Furthermore, the presence, or absence, of evidence for particular building materials is considered a reliable indicator of the nature of a site, excavated or not. The labels chosen to characterise rural settlement at level 3 are rural settlement – stone-built, and rural settlement – post-built.

A1. Rural settlement –stone-built

Ideally the material evidence at a site classified as stone-built would consist of natural stone used as building material, concrete and ceramic building material (find material categories 1, 2 and 3), plus at least one of the miscellaneous artefacts category (category 9). However, this is not always the case, therefore the minimum criteria are as follows. Natural stone is only seen as an indicator of a rural settlement when at least one of the miscellaneous artefacts types of finds are found on site too, because in some parts of the study area stone is found naturally. If natural stone is lacking in the find assemblage, a site can only be characterised as stone-built when both Roman concrete (category 2 and ceramic building material (category 3) was found, in combination with at least one of the subcategories of category 9. In the case of cropmarks, proof of dating in the form of material from category 9, in combination with either natural stone, concrete or ceramic building material has to be present. The same applies to (rectangular) earth mounds still visible in the landscape. It was decided that the presence of ceramic building material alone in combination with (an) object(s) from category 9 was not sufficient to characterise a site as stone-built. This is because, in other parts of the Roman northwest, post-built

57 See for example Nuniger 2002, 71, Taylor 2007, 27-28.

58 For example Nouvel 2009, 369, Taylor 2007, 23-27.

59 Nuniger 2002, 73-75.

60 Nuniger 2002, 71.

settlements have been found where ceramic building material and/or natural stone was used in the construction, either as reinforcements for timber structures, or as visible architectural elements, such as a *porticus* –style addition to a house covered with roof tiles.[61]

As pointed out earlier, on many rural settlements both stone-built and post-built structures were present. Therefore it was decided that in these cases the stone-built structure determines the classification of the site as 'stone-built'. However, it must be proven that the post-built structures were contemporary to the stone-built building(s). If it was unclear from the source whether this was the case, both types of settlement were mapped individually during the first data recording phase.

A2. Rural settlement – post-built

Definite proof of a rural settlements built using only organic materials, such as timber, thatch and loam are ground features such as postholes and ditches (category 4), in combination with items from category 9 for dating. As these features can only be obtained by means of invasive research, it is impossible to reliably demonstrate this type of site by means of non-destructive methods such as field walking. The presence of any item of category 9 on the surface could be seen as evidence of this type of site, although the reliability of this interpretation could be questioned. It was therefore decided that, in the characterisation of the basic dataset, the minimum criteria for this type of settlement was evidence of material from both categories 4 and 9.

A3. Types of urban/nucleated settlement

In addition to the two types of rural settlement, a third type of site was defined at level 3 of interpretation in the category of settlement evidence. An important transformation of the settlement landscape in the provincial-Roman landscapes of northwest Europe was the development of the nucleated settlement with an urban character. Depending on the size and character of the original settlement, the archaeological evidence for this type of settlement can be anything from quadrangular street plans, urban elements such as a forum with a basilica and temples, a wall enclosing the urban space, to a concentration of dwellings in a regular lay-out, usually alongside a road. Houses within nucleated settlements are often made with stone, ceramic building material and concrete. At level 3 a distinction is made between smaller urban centres (*vici*) and larger 'official' Roman towns, such as the two *civitas* capitals in the region, which are also known through historical sources.

B. Funerary evidence

The second category of archaeological evidence concerns the remains of Roman funerary practices. Burials are an important element of the provincial-Roman landscape, often reliably identifiable by the presence of human remains. In the study area cremation was the most common funerary practice for most of the Roman period, so the human remains found are typically cremated bone. As indicated in chapter 1, evidence of funerary practices can be directly connected with the beliefs and rituals of the inhabitants of the region. The classification 'funerary evidence' is given to individual burials or groups of burials. This type of site consists of material from find category 7 (compulsory), in combination with either one of categories 1, 3, 4, 5, and/or 9.

The presence of human remains, either cremated or inhumated, (category 7) is obviously the most important criterion for characterizing a site as funerary evidence. Other elements, however, such as the container, the pit in which the container is placed, and a possible marker of the burial above the ground are also possible. A distinction can be made between 'regular' and 'special' funerary evidence. Regular burials consist of the cremated or inhumated remains of a person, placed in a container in a pit in the ground, usually accompanied by one or more grave goods. Special burials are characterised by

[61] Vos 2009, 238-239.

specific markers above, and/or below, the surface. Above the surface this marker could be an earthen mound or a stone construction. The earthen mound is called a *tumulus*. Stone funerary monuments typically consist of a carved stone pillar of monumental dimensions, located within a square enclosure formed by a (low) stone wall. There are different types and they are given different names by different authors such as mausoleum, grave pillar, and tower tomb.[62] In this study they will be indicated by the more generic term 'stone funerary monument' in this study. Rarely is such a monument found intact, making it difficult, if not impossible, to assess its original character. In order to avoid confusion, the generic term is used, rather than the more specific terms for the different types of stone monuments.

A third type of funerary monument was placed underground. Large coffins of stone were used to hold the cremated remains of the deceased, often together with grave goods. These have often (erroneously) been labelled 'sarcophagi'.[63] There are examples of imitations of this type of practice, whereby the stone container is substituted, for example by a construction made from *tegulae*. In this study such funerary evidence will be called 'large stone incinerary urn'. These special burials usually have large assemblages of valuable items from category 9, such as objects of glass and precious metals.

C. Road network evidence

Features concerning infrastructure, such as roads and bridges, are seen as an important separate category, as they are an another important element of the provincial-Roman world. The quality of the Roman road network, stretching throughout the empire, connecting every province to Rome, and their associated features, such as bridges, inns and milestones, were well-known even in the early days of archaeology. As with the settlement and burial evidence, many researchers set out to locate and reconstruct the Roman main roads in their countries. The famous Roman maps, the *Tabula Peutingeriana* and the *Itinerarium Antonini*, both of which depict the road that connected the towns of Atuatuca Tungrorum with Colonia Claudia Ara Agrippinensium, inspired many researchers to search for the main road, whereby a paved surface was seen as the main body of evidence.[64] However, this has resulted in a number of sites, identified as roads, but which only have a layer of gravel as their archaeological evidence, without further information concerning dimensions or related features, such as ditches. Some of the 'sites' recorded in the region do not even consist of archaeological material, but are based on shape (a straight line) or the name of a current-day or recent road, for instance with the word '*steen'/'stein*' (= stone) or '*heer'/'heir*' (= army). Another difficulty with this category is that layers of gravel are found as natural substrates in many parts of the study area. This means that invasive research is required to ascertain that a particular site formed part of a Roman main road, rather than being a natural substrate. Furthermore, under Napoleon's rule, several roads in Belgium and the Netherlands were constructed or improved with pavements, such as the road from Maastricht to Tongeren, and Maastricht to Vaals, and these were often called '*steenweg*' or '*heirbaan*'.[65] With this category of evidence, therefore, it is very important to assess the reliability of the information. It was decided from the start that only sites with a specific type archaeological evidence would be considered for this category.

Recent archaeological fieldwork in the study area has provided us with detailed information concerning the composition of (main) Roman roads here. A hardened road of 6 to 8 meters wide formed the most recognisable element, although in this part of the empire it was not paved. Instead, it consisted of several layers of different types of material, such as large and smaller fragments of natural stone, and pebbles / gravel. For example, at Voerendaal in Dutch Limburg, a trial trench across the Roman main road between Heerlen and Maastricht showed that Kunrader limestone was used for

62 Crowley 2011, 198.

63 Crowley 2011, 200 and in prep.

64 See for example Byvanck 1947, where the evidence of roads is in many cases described as 'kiezelbedding' (gravel bed).

65 Renes 1988, 177.

the bottom layer, with several layers of clay mixed with coarse and fine gravel on the top.[66] Excavations in the German Rhineland have shown adjacent unhardened paths, each 6 to 8 meters wide, on both sides of the hardened road.[67] This suggests that the road in total can be up to 25 meters wide. Apart from these main roads, secondary roads have been found in several locations, with an average width of 4 meters, and consisting of pebbles and gravel in layers of clay.[68] Following these excavation results, evidence for a (stretch of) main road fits into category 1. A significant problem is the dating of a (stretch of) road to the Roman period. Datable material, such as ceramics, coins or other objects in category 9, are only seldomly found.

As the research region contains many small brooks and rivers, bridges are another important element of the Roman road infrastructure. Remnants can be made of stone, wood, or a combination of the two. Like roads, the remains of bridges are difficult to date reliably, although in some cases the wood is suitable for dendrochonology.

D. Evidence of specialist economic activities

One of the key developments in provincial-Roman society was the specialisation of artisanal production, such as iron, pottery, textile, glass, or leather. Production of such goods had traditionally taken place within the context of the rural settlement; but the Roman period saw the development of particular areas of specialised production, usually at *vici*. In order to analyse the location and scope of this development in the study area, it was decided to register those sites where evidence for such specialist craft activities had been found. Evidence for these activities mainly consists of workshops or kilns, especially for the production of pottery, metal or glass. Criteria were set up in order to distinguish between specialist craft activities and artisan activities at a predominantly agrarian settlement. For example, a single kiln is not seen as sufficient evidence for this category. Several kilns found in a roadside village, however, are interpreted together as one centre of specialist craft activity. The two main towns in the study area, Atuatuca Tungrorum and Colonia Claudia Ara Agrippinensium, are not specifically registered as being specialist craft activity sites, as such activities are considered as just one of the many functions of these centres.

The actual archaeological evidence consists of very specific elements, in combination with other material, such as the building plans, either stone-built (find material categories 1, 2 and/or 3) or post-built (find material category 4), together with material from categories 8 and 9. Kilns, for example, were made of clay, have a recognizable 'keyhole' shape, and often contain remains of artefacts, such as glass or pottery. Iron production can be evidenced by slag heaps and smelting heaths, as well as tools used in its production. The workshops of blacksmiths, carpenters, masons, cobblers and other artisans are more difficult to prove. Nonetheless, specific evidence from category 9, such as specific types of tools, can help to identify industrial artisan production, for example in a *vicus*.

Evidence for quarries and mines are difficult to establish, mainly because dating can be an issue, but also because activities often continued there after the Roman period, destroying any evidence of the earlier activities. However, there are sites that can be identified as such, commonly through association with find material from category 9.

E. Evidence of specific roman features

Amongst the variety of sites found in the study area, some are of a very specific nature. For this study, the following specific features are identified: sanctuary, *burgus,* military camp, *statio*, watch tower, waterworks, such as aqueducts and bath houses, land division ditches, and *horreum*. Identification

66 Tichelman in prep.

67 Gaitzsch 2004, 181, 185, Andrikopoulou-Strack 2004, 166-167.

68 Information from the ABR and Archis2 databases.

of these features is important for several of the research questions. For the questions relating to the settlement landscape, features such as the *burgus* and the bath houses give additional information for developments in settlement forms; sanctuaries can provide information regarding the cosmological and ritual landscape; and data regarding land division ditches and *horrea* can give added information about the landscapes of production.

Only excavation, preferably of the entire structure, enables the recognition of the particular form and shape of these features. If only partially examined there is a real chance that they can be mistaken for other structures.

Sanctuaries can be recognised by a specific plan and layout, preferably in combination with certain small finds. These features can be mistaken for settlements, as the material is of a similar nature: square or rectangular stone wall foundations, with roof tiles and mortar. It can easily be imagined how a trial trench revealing only part of the structure would result in the interpretation of the site as a Roman stone-built house. In addition, there could very well have been other, less recognisable sanctuaries, possibly built using only organic materials, that have not been recognised as such.

The same applies to the *burgus*, which is a civilian defensive structure, commonly dated to the Late Roman period. The evidence usually consists of a heavy square foundation made of stone and mortar, surrounded by one or more v-shaped ditches. Large scale excavations of rural settlements in the Hambach region have shown in at least two instances that these *burgi* were built on the periphery of rural settlements of a stone-built character.[69] This has indicated a strong connection between the two structures. When only the foundations of the square tower are unearthed, it can be interpreted as part of a stone-built house or as a sanctuary. However, this feature in particular has also been interpreted as a military feature, namely the watch tower.

Although predominantly 'civilian', the research area boasts three types of sites that fall under the denominator of 'military sites': military camps, *statios*, and watch towers. In the early days of Roman archaeology, military features received a great deal of attention and therefore many of the early researchers went looking for these features. The interpretation of sites as 'watch towers', in particular, is questionable as many researchers now believe they were not as omnipresent as previously thought. On the other hand, modern excavations have enabled archaeologists to identify very specific features that were not recognised in the early days. A typical example is the *statio*, a gendarme-like post where Roman *stationarii* or rural gendarmes were permanently stationed at strategic points on the road network, in order to control the flow of traffic within the region. [70]

Category 5 contains two types of feature that are related to water: bath houses and aqueducts. Roman bath houses are usually highly recognisable by the particular shape of the building and the layout of individual rooms (heated rooms, *piscinae*, *praefurnia*). A distinction can be made between private bath houses, usually found near, or attached to stone-built dwellings in a rural setting, and public bath houses, which in most cases are located in *vici* and towns. In this study, the bath houses in the 'special feature' category are public bath houses; private bath houses are mapped as attributes to settlements. The second type is the aqueduct. The Roman world is famous for the many different ways in which water was controlled, supplying everything from individual rural settlements to large towns. Aqueducts were made from many different materials, such as wood, lead, stone and mortar or earth works.

The last two types in this category are storage buildings, or *horrea,* and ditches. Although storage structures were already regular features in rural settlements in the pre-Roman period, they underwent a transformation, both in architecture and size, after the conquest. This is often seen as evidence of surplus grain production, although recently it has also been interpreted as another form of ostentatious display.[71] Apart from the *horrea* at rural settlements, large scale storage buildings were also present in

[69] Information from the ABR dataset.

[70] Given 2004, 57.

[71] See for example Habermehl 2011.

urban locations. As it is assumed that these horrea are indicators of large-scale surplus production of grains, it was decided to map these features. Of course the same applies here as with the other features in this category: some of these structures might have been interpreted as settlements, particularly when only non-invasive or partial excavation was carried out at the site, because the find material is essentially the same. Also, *horrea* made only from organic materials might have been missed or interpreted as regular post-built dwellings. Another problem with this feature is that they are not explicitly mentioned by some sources. Therefore it must be assumed that the results for this type of feature are less reliable than some of the other types of sites.

It was also decided to map those sites where ditch systems related to field organisation were found. This was done in order to shed light on the off-site organisation of the landscape and the related question of *centuriatio*. A recurrent issue when dealing with Roman rural landscapes, *centuriatio* implies the strict reorganisation of land in the new provinces, whereby former properties were reissued according to Roman standards, and/or the expropriation of land in favour of veterans. If the study region had undergone such a reorganisation, as has been argued in the past by different researchers,[72] archaeological evidence in the form of rectilinear ditch systems are to be expected in sufficient quantities.

F. Indefinable evidence

As already noted, the classification process leaves a number of site remains that do not comply with any of the criteria. It was decided to map these sites nonetheless. By themselves, they might not provide much information, but they could prove useful in the reconstruction of the landscape. The chosen subtypes in this group are: coin finds, single finds (material of only one of the nine find material categories), and indefinable (material of two or more of the nine find material categories, that does not meet any of the criteria for one of the five groups of site types).

3.4.3 SPATIAL CRITERIA

Earlier in this chapter the question of how the dataset of this study is a conglomerate of several datasets was addressed, some of which complement each other, and some of which overlap. Figure 3.11 showed that there are examples in the region of areas where several sites have been found in close proximity to each other. The question is whether these sites should be seen, and characterised, as a single settlement (or other feature, depending on the type of material found). It was decided to formulate spatial criteria, in addition to the find materials criteria, in order to determine whether or not sites should be interpreted together. Due to the specific nature of the data categories B – E, a burial, a stretch of road or a pottery kiln would all be recorded as such, regardless of the distance between it and its nearest neighbour. So it was clear that most of the decisions would have to be made regarding sites within categories A and F.

It was decided, therefore, to take the average dimensions of settlements in the study area, established by means of excavation, and use this size as a measuring tool. The average size of a Roman settlement in the study area was 100 by 250 meters.[73] So when two or more sites, individually characterised as being of category A or F, were found to be within 250 meters distance of each other, these sites were considered to be parts of the same settlement, and this one settlement was classified as such. This way, items from category F are incorporated in the settlement category.

[72] See for an overview of the literature on this subject Roymans / Derks 2011, 11-13.

[73] See chapter 5, this volume, for more information regarding the calculation of the average size of a Roman settlement in the study area.

Another important guideline used during the characterisation of the dataset, was that features that had been obtained during the same archaeological activity, for example an excavation, are seen as a finds assemblage, and characterised as such. Therefore an excavation of a rural settlement with several auxiliary buildings is characterised as a single site in the settlement category, even if the remains of a pottery kiln, for example, was found amongst these auxiliary buildings. However, if features were found during separate activities, the sites are characterised individually; whether or not they should be interpreted together was left open in this phase. In the next phase, when the rural landscape will be reconstructed, these cases will be further explored.

4. Introducing the archaeological dataset

The dataset that was made through the procedure described in the previous chapter will now be presented using maps, graphs, and an explanatory text. Following the protocol of the three different interpretation levels described in chapter 3, first the overall dataset will be presented, followed by the five main categories and subcategories of sites. As maps play an important part in both the data analysis and presentation, it was necessary to decide on a standardised format to be used in this chapter. For the presentation of the dataset a set of places acting as anchor points are depicted on each map, in order to help the reader locate particular areas within the study area. The places chosen for this were the main urban centres in the Roman period, such as *Atuatuca Tungrorum*, *Coriovallum*, and *Juliacum*, as well as the border of Dutch Limburg, in order to distinguish the three countries within the study area, and the two main rivers Meuse and Rhine. If deemed necessary or functional, other elements are shown, such as the location of the loess soils. The terminology used in this chapter is the same as that explained in the first part of chapter 3. As the dataset is presented with the aid of maps, the word 'point' will be the most frequently used term in this chapter, referring to the individual items, features and sites stored in the database of this study.

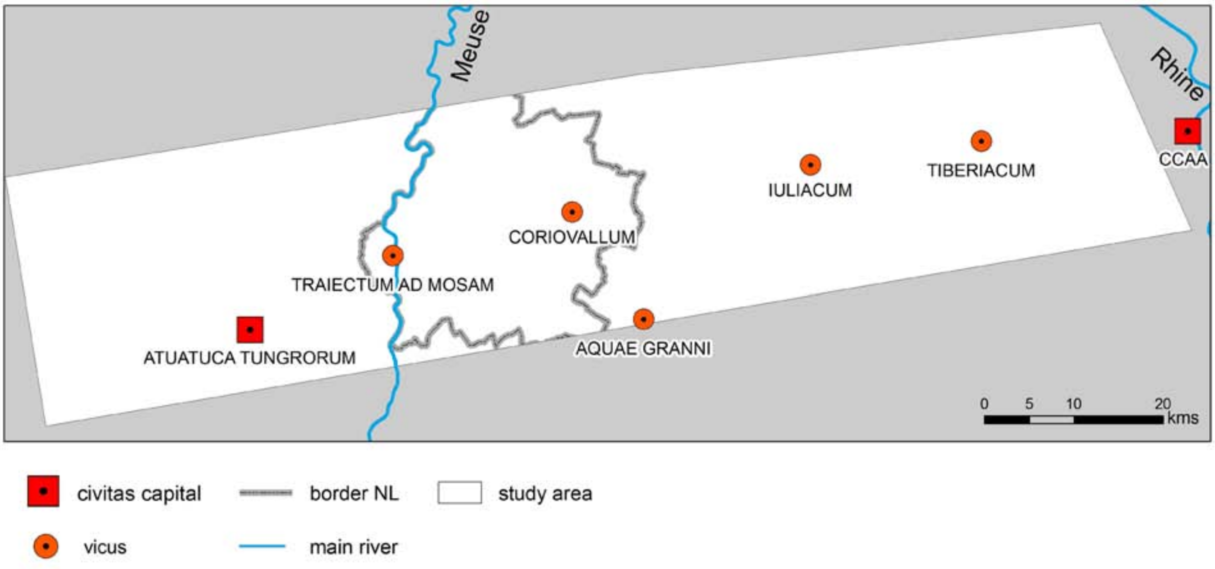


Fig. 4.1. Map of the study area (scale of 1:400,000), showing the Roman towns, the two main rivers and the border of Dutch Limburg, with Belgium located to the west and Germany to the east.

4.1 THE OVERALL ROMAN LANDSCAPE

Chapter 3 explained the process behind the determination of a point in the database. A total of 4777 points were registered in the original database; re-evaluation resulted in a dataset of 3047 points, the spatial distribution of which is shown in figure 4.2. This means a reduction of 1730 points. Of these

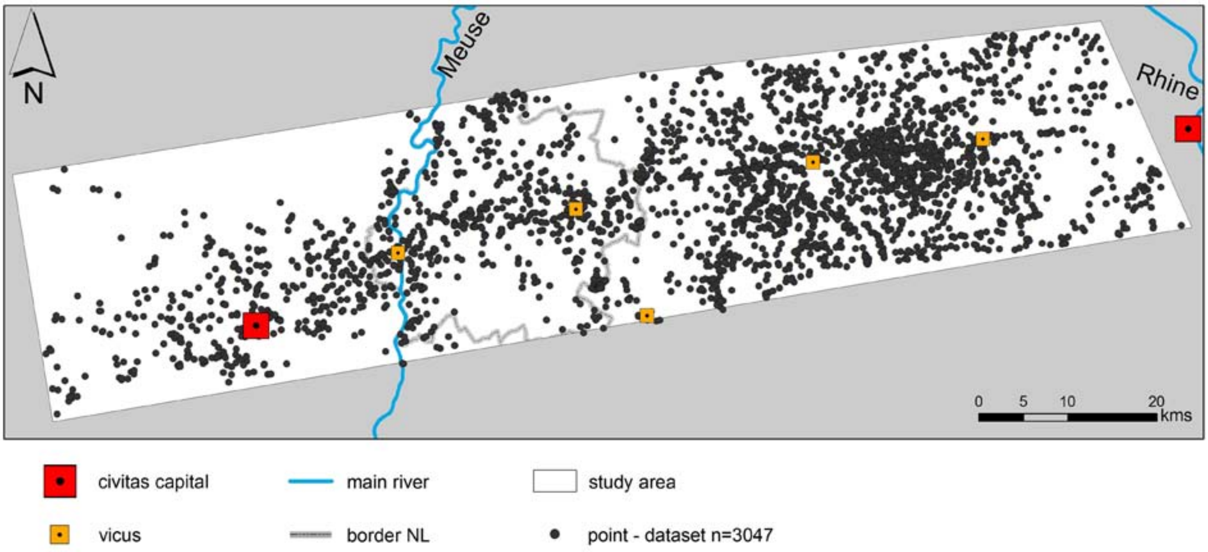


Fig. 4.2. The distribution of the 3047 points in the dataset for this study.

Excavation:	519
Rescue operation:	456
Trial trench:	26
Coring:	6
Field survey:	1183
Aerial survey:	22
Observation:	55
Metal detecting:	114
Historical source:	23
Unknown:	643

Table 4.1. Type of archaeological method used to identify the 3047 points in the study area, with a percentage breakdown shown on the right.

3047 points, 445 are located within the Belgian part of the study area, 618 within the Dutch part, and 1984 are located in the German part. The number of points per country should be compared to the size of the area in which they are located. The area of the entire research region measures 3441 km^2; 1636 km^2 or 48% of this is on German territory, 1206 km^2 (35%) on Belgian and 599 km^2 (17%) on Dutch territory. Comparing the proportions of points per country with the proportions of area per country, the following observations can be made: 65% of the points are located in 48% of the study area (G); 20% in 17% of the study area (NL) and 15% are located in 35% of the study area (B). Whether or not this indicates a difference in settlement density in the three regions during the Roman, or whether this is caused by some other factor will be further examined in chapter 5.

The dataset will now be interrogated using the attributes, 'type of research' and 'date' in order to provide more general information about the research history of the dataset. Of the 3047 points, the type of archaeological activity is not known for 643 points, roughly one fifth of the entire dataset. Of the remaining 2404 points, 1007 were obtained by means of invasive research (excavation, trial trench, coring or rescue operations) and 1397 points were the result of non-invasive research such as field survey, aerial photography, and historical sources. This means that nearly half of the dataset was generated by non-invasive methods.

The information above allows for some observations. It is, for example, remarkable that so many points were obtained through rescue operations. Many of these were carried out prior to 1945. Most sites seem to have been located through field-survey, however, it will be shown that this was not the case for each of the three countries. Another observation is that aerial photography appears to be

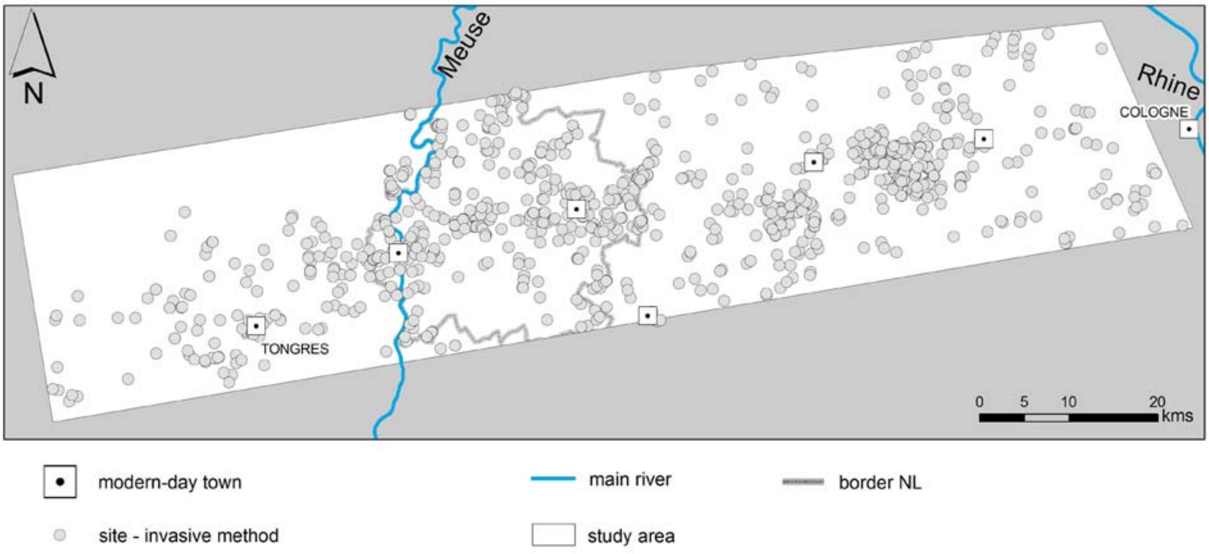


Fig. 4.3. The dataset n=3047, showing the sites obtained by means of invasive research.

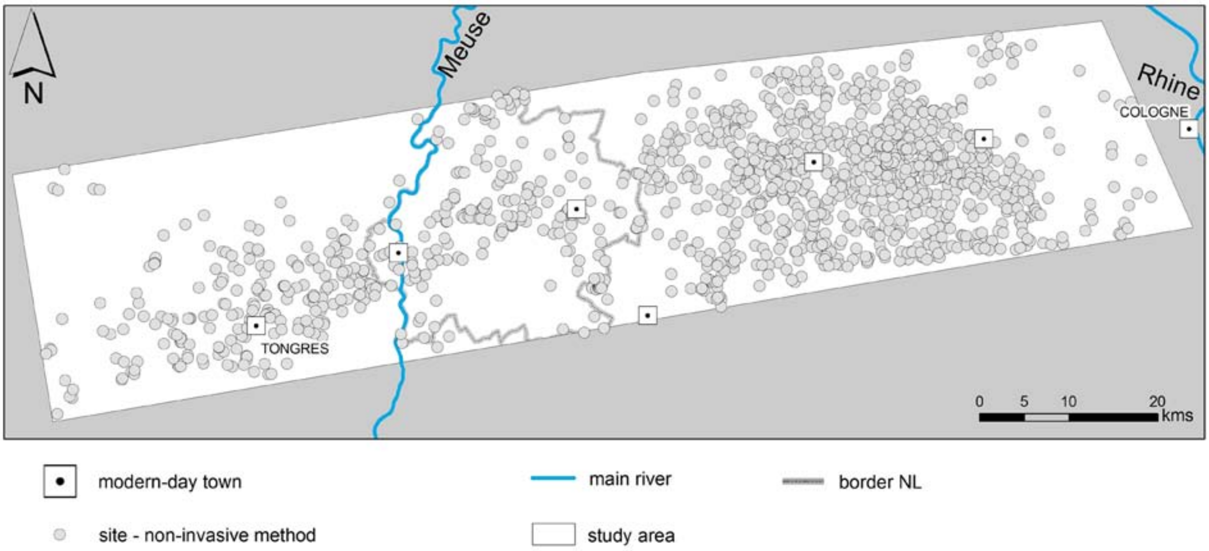


Fig. 4.4. The dataset n=3047, showing the sites obtained by means of non-invasive research.

rarely used in the region. This is remarkable because, in theory, the loess soils with their current use for arable farming form ideal circumstances for this type of survey, as proven by French archaeologist Agache in the north of France, where similar circumstances exist.[1]

Looking at the distribution of points in terms of how they have been identified, figures 4.3, 4.4 and 4.5 show that the data generated in Germany is predominantly the result of non-invasive research, although a cluster of sits found via invasive research can be seen east and west of Jülich, related to the lignite extraction here. In Dutch Limburg invasive methods seem to have been the more dominant type of research, whereas archaeological evidence in Belgian Limburg seems to have been generated by an equal proportion of invasive and non-invasive field methods. The proportions shown in figure

[1] Agache 1978.

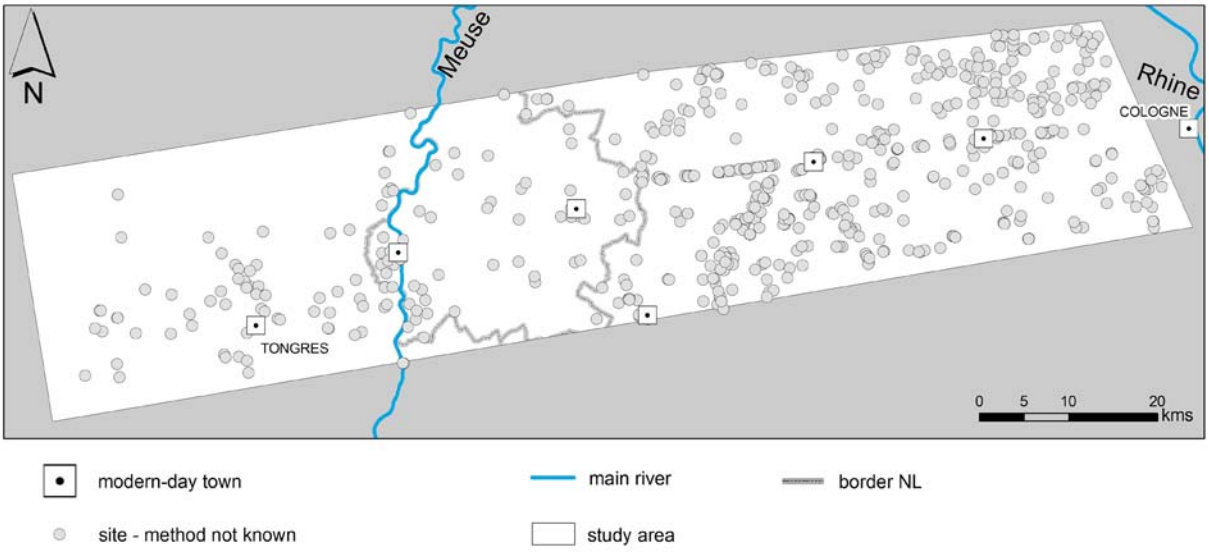


Fig. 4.5. The dataset n=3047, showing the sites for which the method was not known.

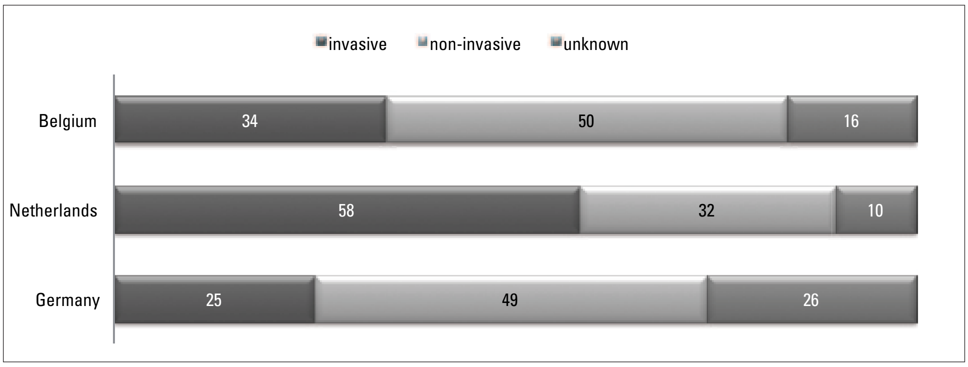


Fig. 4.6. Graphs showing the proportions per dataset (from the German, Dutch and Belgian parts of the study area) of how sites were identified archaeologically.

4.6 substantiate these observations. When analysing the various patterns in sites, these differences in the standard practices of the three countries comprised in the study area should be kept in mind.

Dating of sites

When the dataset is analysed for the attribute 'date', a rather astounding number of 2324 points, more than ¾ of the entire dataset, cannot be dated beyond the generic 'Roman period – undefined'. This indicates a significant limitation in the knowledge of the Roman landscape in the study area. Less than a quarter (723, which equals 24%) of all dataset items have been dated more precisely. This already suggests that it will be difficult to reconstruct a reliable chronology of the region.

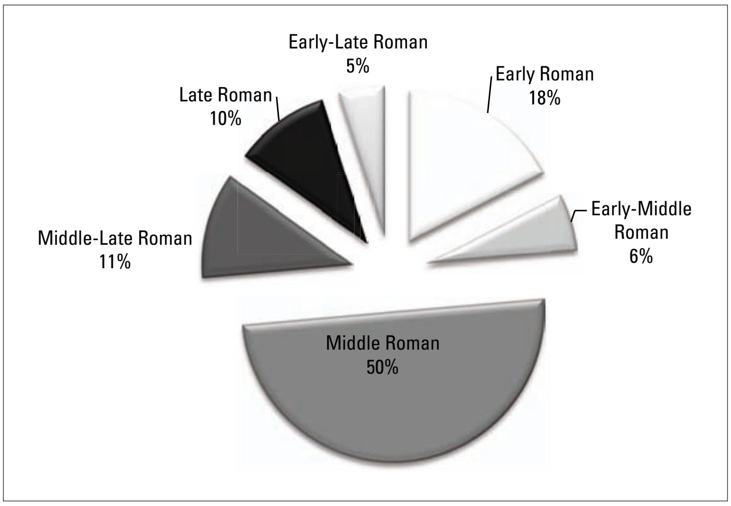
Of the 723 dated points, the majority (50%) are dated to the middle Roman period, i.e. the end of the first century AD to the beginning of the third century. Interestingly there seems to be an equal proportion of points dated to the early Roman and late Roman period (24% and 21%, respectively). Only 5% seem to have been present throughout the entire Roman period.

Examining the statistics per country, it appears that the proportions of precisely dated points compared to those dated as 'Roman-undefined' are not that divergent, as shown in figure 4.7. This is interesting, as the dominant type of archaeological activity per country is very different, as was noted earlier. Apparently the fact that invasive methods are more commonly used in one country does not influence the information generated, regarding dating of a site.

Using only the dated sites it is possible to reconstruct a map per period. The first map, of the early Roman period, shows a distinct spatial pattern. The Dutch and Belgian part of the study area show a

early Roman:	126
early-middle Roman:	45
middle Roman:	361
middle-late Roman:	82
late Roman:	74
early-late Roman:	35

Table 4.2. Dating of the 3047 points in the total dataset, with a percentage breakdown shown on the right.



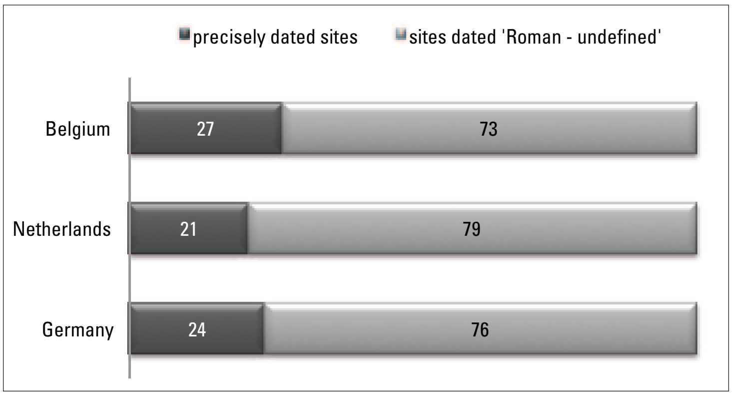


Fig. 4.7. Graphs showing the proportions per dataset (from the German, Dutch and Belgian parts of the study area) of precisely dated sites versus sites dated as 'Roman-undefined'.

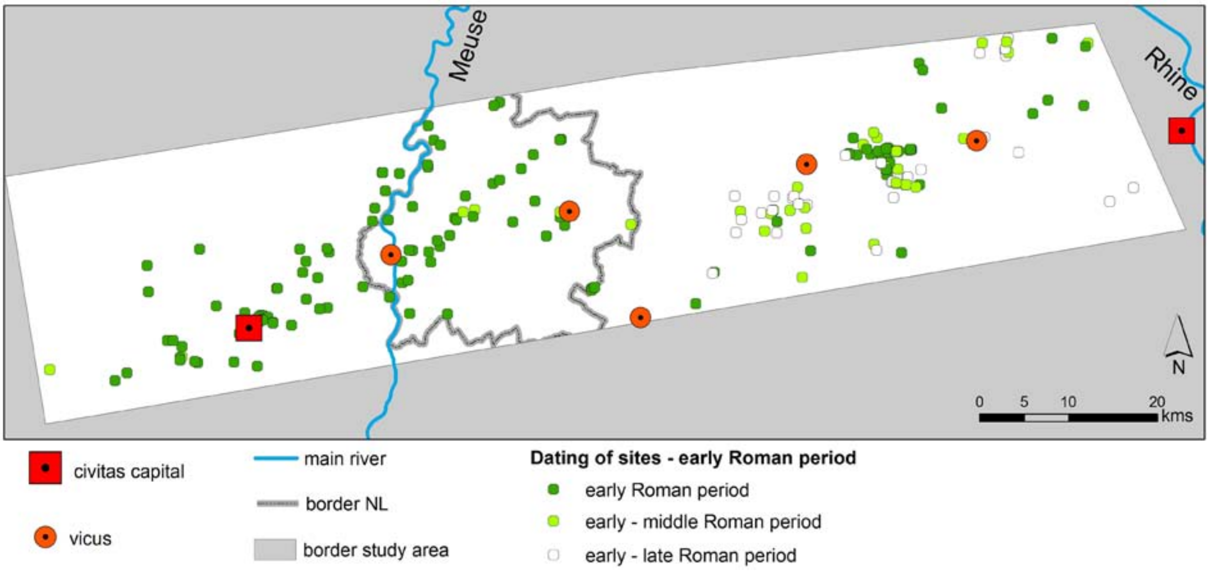


Fig. 4.8. The distribution map of points from the overall dataset dated to the early Roman period.

dispersed scatter of sites, which differs strongly from the pattern in the German part, where these early sites seem to be concentrated between the towns of *Iuliacum* and *Tiberiacum*. The zone between *Coriovallum* and *Juliacum* seems to have been almost empty in the early period. The lack of early Roman sites in the direct hinterland of *Colonia Claudia Ara Agrippinensium* is remarkable.

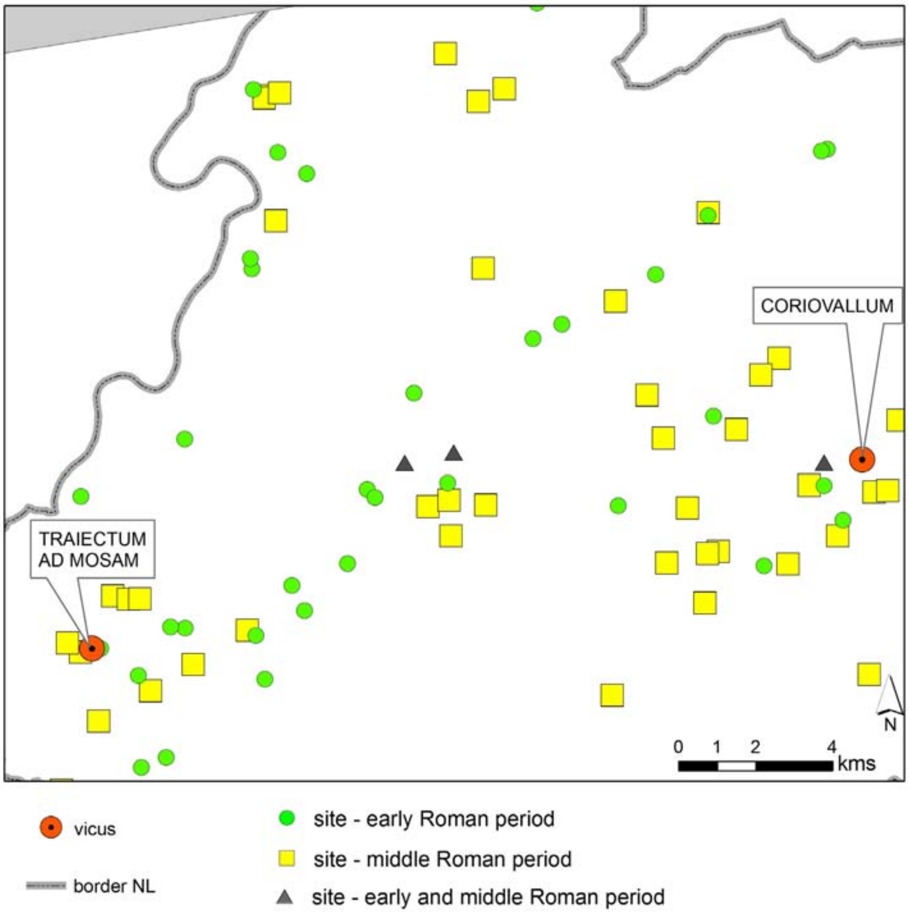


Fig. 4.9. The distribution map of the points from the overall dataset in the region between current-day Dutch Limburg dated to the early, the middle, and the early to middle Roman period.

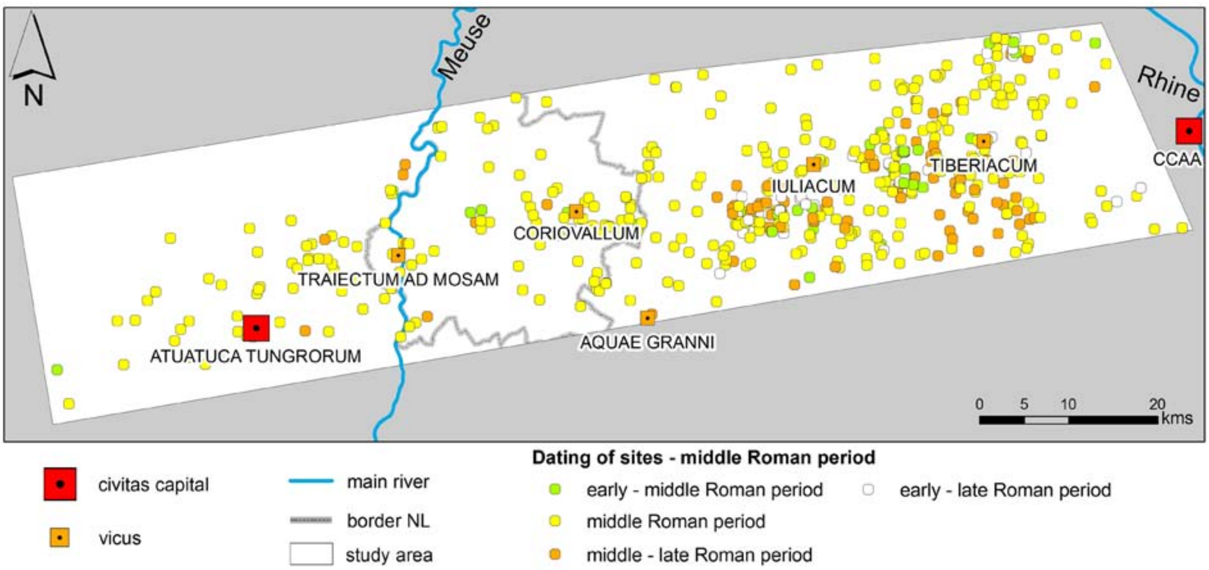


Fig. 4.10. The distribution map of the points from the overall dataset dated to the middle Roman period.

An important line of inquiry regarding the provincial-Roman landscape concerns the question of continuity and discontinuity. Figure 4.8 demonstrates that there seems to be little continuity of sites starting in the early Roman period in Dutch and Belgian Limburg. This seems to suggest discontinuity of habitation in the region east and west of the Meuse at the end of the first century AD. In the

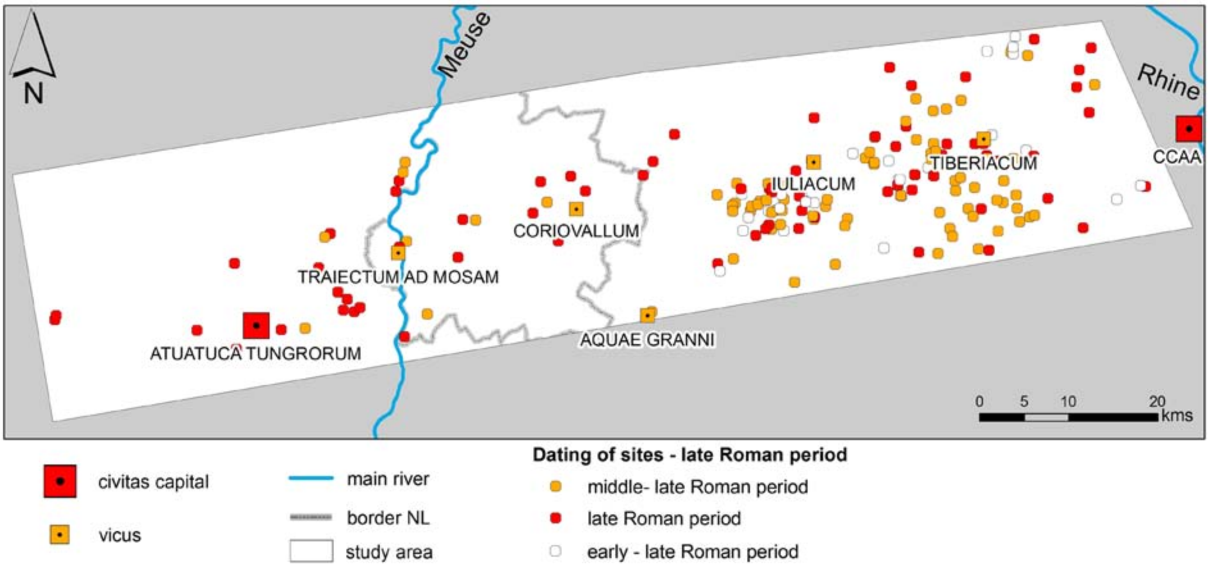


Fig. 4.11. The distribution map of the points from the overall dataset dated to the late Roman period.

German region, however, there seems to be more continuity, as evidenced by a higher number of sites dated either as early to middle, or even as early to late Roman.

Continuity from the early to the middle Roman period can be further examined by visualising sites dated as early Roman, middle Roman, and early to middle Roman, as was done for part of Dutch Limburg, shown in figure 4.9. The resultant map seems to indicate that there are very few sites dated to both periods (shown as triangles) suggesting there was little continuity between the two periods, evidenced by a noticeable lack of overlapping sites (the square and the dot at one location). Does this mean that most sites in the area were newly built sites, suggesting a hiatus between the two periods? This should be examined in the future, as at this point it is not clear to which category of evidence these sites belong.

Compared to the early period, the middle Roman period showed a substantial increase in the number of sites. Although it is tempting to see this as evidence of a large increase in the population of the region, more information is needed before this conclusion can be drawn. It seems that the increase in number of sites took place throughout the entire region, with the exception of the hinterland of Colonia Claudia Ara Agrippinensium and the region north and northwest of Atuatuca Tungrorum.

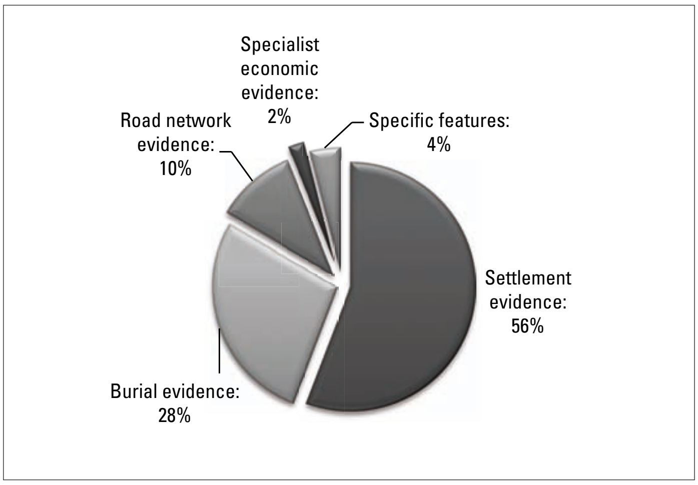
The sites dated to the late Roman period show a different distribution pattern compared to the previous periods, with the majority of sites located in the German part, and few sites in the Dutch and Belgium part of the study area. This seems to be the reverse of the situation in the early period. Again, further analysis is needed to substantiate these observations. The map demonstrates that a much higher number of points in the German part of the study area were dated middle to late Roman, compared to the Belgian and Dutch part of the region. This pattern seems to suggest continuity of habitation in the eastern part of the study area, with a higher degree of discontinuity in the western part. Overall, the maps indicate a distinct pattern of rise followed by a subsequent decline throughout the entire region.

4.2 CLASSIFYING THE ROMAN LANDSCAPE

Now that the overall dataset has been introduced, the results for data interpreted at level 2 will be presented. Of the 3047 items in the overall dataset, 2333 or 77% are attributed to one of the five defined categories. This means that the remaining 714 points are seen as 'indefinable evidence'. The

n=2333	
Settlement evidence:	1301
Burial evidence:	646
Road network evidence:	246
Specialist economic evidence:	48
Specific features:	92

Table 4.3. Division of the 2333 items over the five main data type categories, with a percentage breakdown shown on the right.



2333 items are distributed over the five main categories as shown in graph 4.3. It shows that, of the definable items, more than half are characterised as settlement evidence, with burial evidence forming the second largest category at 28%. Only 2% of all find spots are seen as evidence of specialized economic activities, and slightly under 5% consist of specific Roman features, including cult sites. This leaves 10% of sites characterised as evidence of road networks. The five different categories will now be introduced, starting with the settlement evidence.

4.2.1 CATEGORY 1: SETTLEMENT EVIDENCE

The first thing that stands out from the map shown in figure 4.12, below, is the obvious differences in site numbers across the study area. The many points located in the German part are in stark contrast with the significantly lower number of sites in the rest of the region. Possible reasons for this difference will be explored further in chapters 5 and 6, where several factors are examined for their perceived influence on settlement density.

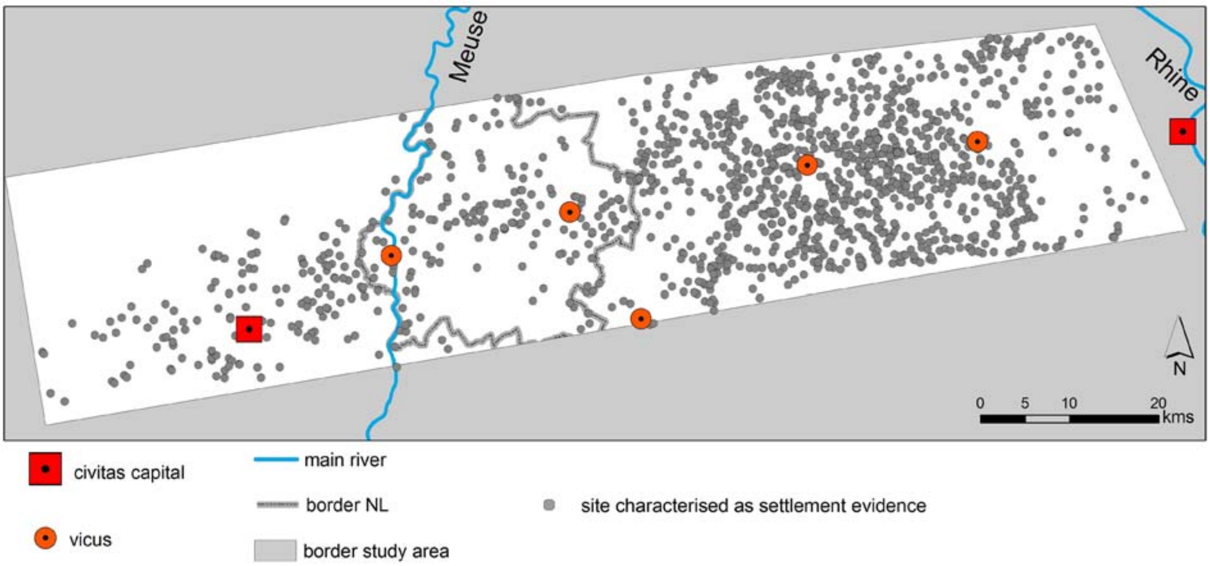


Fig. 4.12. The distribution map of the sites characterised as settlement evidence.

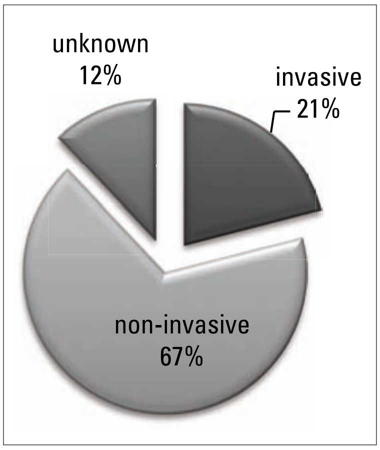


Fig. 4.13. The proportions of points characterised as settlement evidence, (category 1), as found by the three main types of archaeological activity.

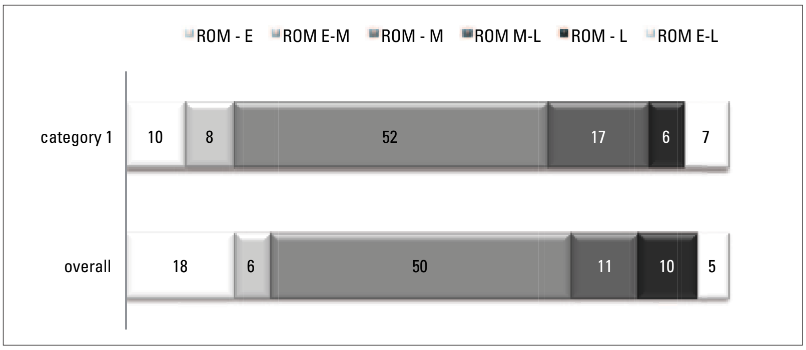


Fig. 4.14. Comparison of the proportions of sites characterised as settlement evidence, per period in comparison with those of the overall the overall dataset. The numbers represent percentages.

The overwhelming majority of items in this category of data, (67%), were obtained through non-invasive archaeological research, in particular field survey. Invasive methods such as excavations and rescue operations make up just one fifth (21%) of the dataset, with 12% resulting from an unknown activity.

Of the items characterised as settlement evidence, 50% could not be dated beyond the generic 'Roman undefined'. Of the 372 more precisely dated points, 194 (52%) were dated as middle Roman. 10 and 8% of the remaining sites were attributed to the early and early to middle Roman period respectively), with 17% and 6% respectively to the middle to late and late Roman period. 7% were dated as early to late Roman. Since this category constitutes the largest group of items, it is not surprising that these numbers are similar to the overall trend in dating observed in 4.1, although some subtle differences can be discerned. For example, the proportion of settlement sites dated to the early Roman period is substantially smaller than that of the overall dataset, whereas the proportion of sites dated to the middle to late Roman period is somewhat larger than that of the overall dataset.

4.2.2 Category 2: funerary evidence

It has already been noted that 28% of all items in the basic dataset could be classified as evidence of funerary practices. The distribution of these points within the overall study area can be seen in figure 4.15.

Map 4.15 shows that the distribution of items in category 2 across the study area seems to be more even in comparison to the settlement evidence. With regard to how sites have been identified, the graph in figure 4.16 shows that in comparison to settlement evidence, the funerary evidence points have predominantly been identified through invasive research, with almost as many excavations as rescue operations. However, there are also a substantial number of sites for which the identification method is unknown. This is because burial sites are relatively easy to recognise, even to the untrained eye, therefore there are many reports of funerary practice evidence in the dataset from which it is impossible to establish the archaeological field method used to identify them.

With regard to the dating information of items in category 2, it is unfortunate that the evidence is even worse than that for category 1, with only 28% dated to a specific period. Considering that,

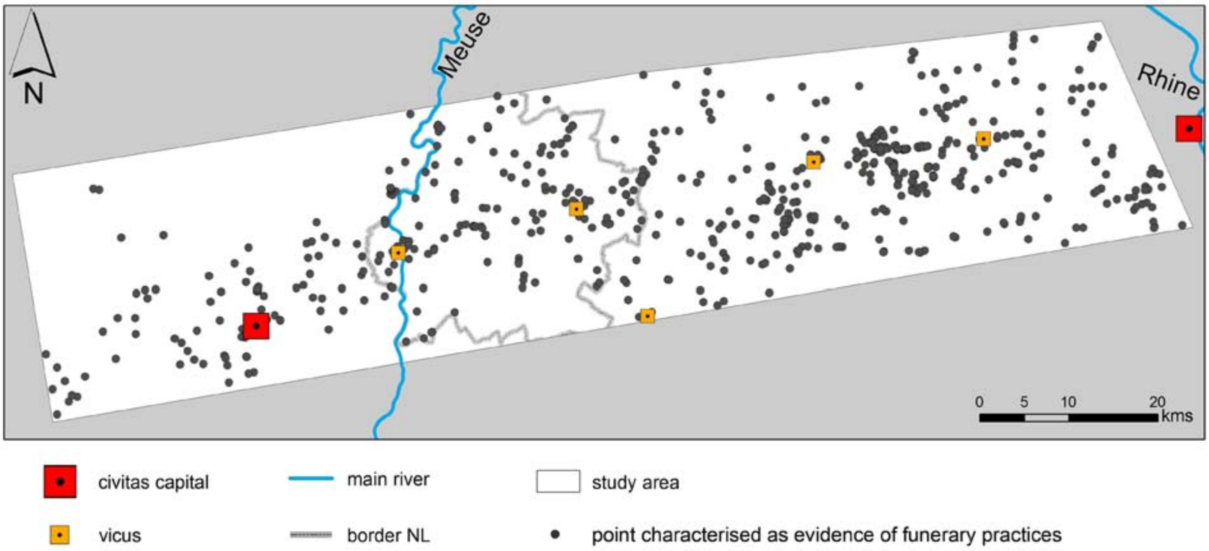


Fig. 4.15. The distribution map of the points characterised as evidence of funerary practices.

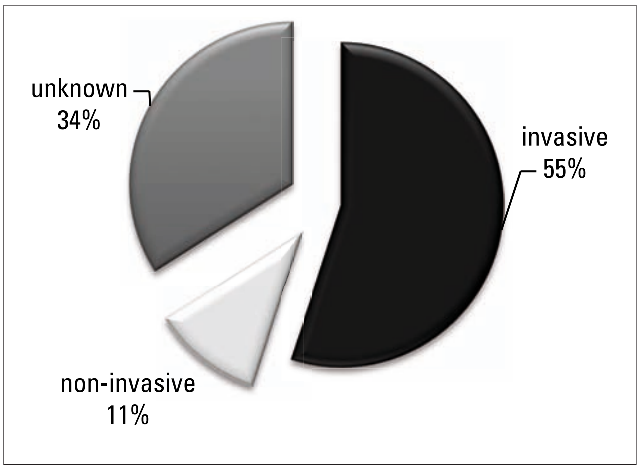


Fig. 4.16. The proportions of items characterised as funerary practice evidence ,(category 2), as found by each type of archaeological activity.

in general, burials consist of intact objects which allow them to be precisely dated, the fact that so little of this evidence provides us with dating information is disappointing. Of the burials that are dated more precisely, over 60% are attributable to the middle Roman period. Compared to the overall dataset, this shows a slightly different pattern.

When the distributions of settlement and burial evidence were compared in the data storage phase, it became evident that both types of sites were often discovered in close proximity. This was, especially notable in cases where a (rural) settlement had been completely excavated. Here, burials seemed to have been deliberately located at the edges of the farmyard. In an urban context burials were usually located just outside of the built area. There are,

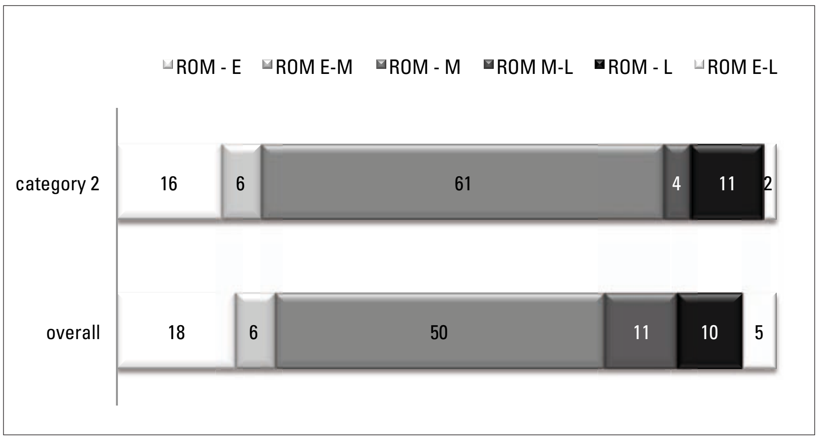


Fig. 4.17. Comparison of the proportions of sites per period characterised as funerary practice evidence compared to those of the overall dataset. The numbers represent percentages.

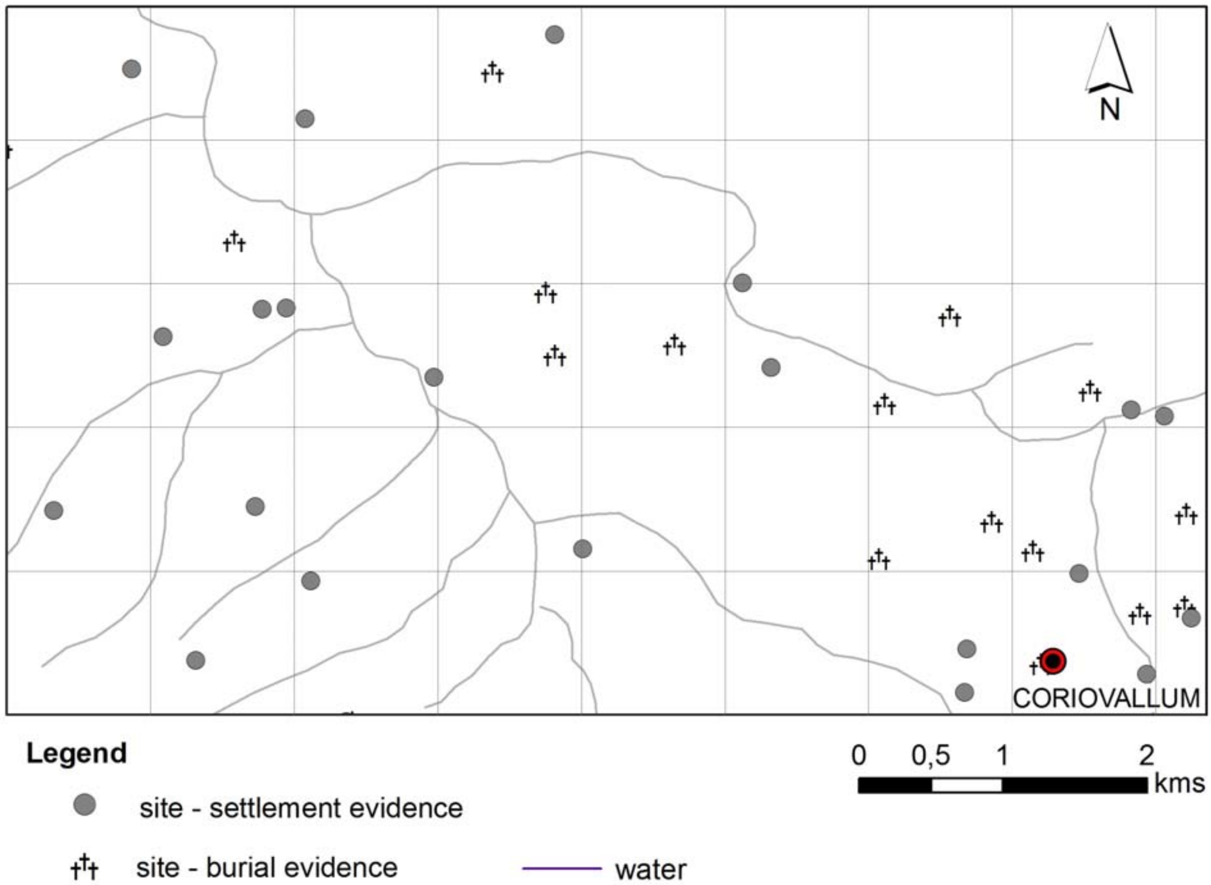


Fig. 4.18. Micro-region northwest of current-day Heerlen, showing numerous individual burial sites, apparently found without any associated settlement evidence.

however, many items in category 2 that seem to have been in an isolated location, apparently with no settlement evidence located close by. Analysis shows that of the 646 items in category 2, 435 were located at more than 250 meters from a settlement site. This is highlighted by the map of the area west of Coriovallum (Heerlen), shown in figure 4.18. The grid of 1 by 1 kilometres shows that most of the points characterised as funerary practice evidence were located far from any associated settlement site.

The question is whether the burials, that appear to have been in isolated locations, were meant to be in that position, or whether they represent evidence of settlements that have not (yet) been discovered? It appears that many of these 'isolated' points are the result of chance discoveries, rather than systematic archaeological activities. This issue will be further addressed in the following chapter, which will examine whether it is possible to reconstruct the rural settlement landscapes in the study area using different categories of data, including burial evidence.

4.2.3 Category 3: Road network evidence

Evidence for Roman road networks form the third largest category in the dataset. In total 246 items were registered in category 3, which constitutes as 10% of the entire dataset. The same caution used with funerary practice evidence should also be applied here, as the evidence does not always correspond to the exact number of actual find spots, nor does it translate into knowledge regarding large stretches of road. For example, it is generally assumed that the main Roman road from Atuatuca Tungrorum

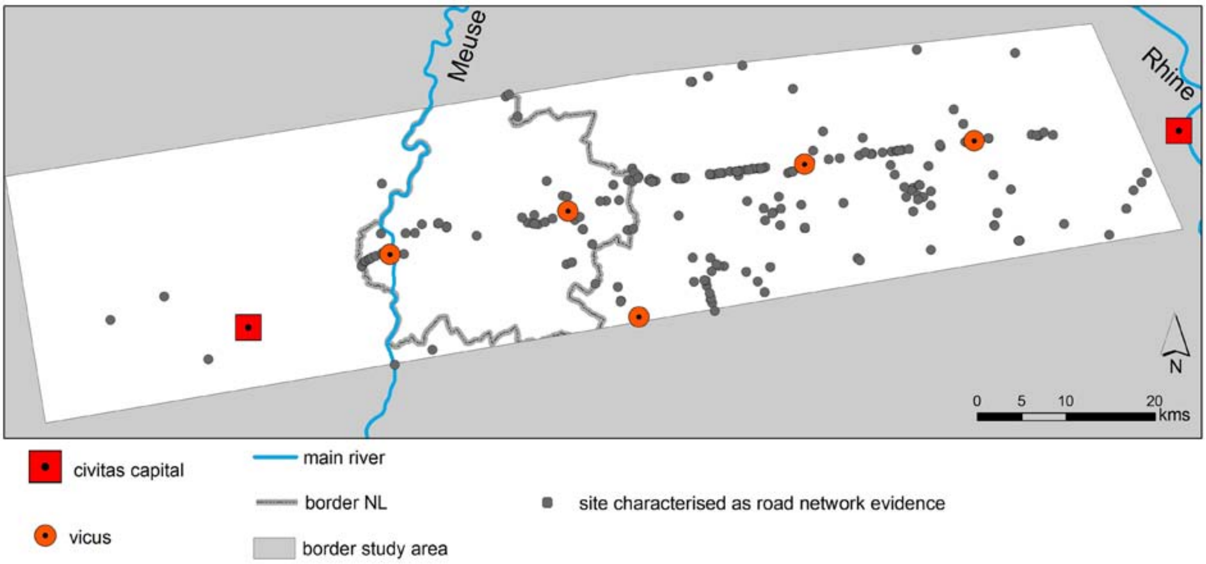


Fig. 4.19. The distribution of points characterised as road network evidence, together with the reconstruction of some of the main roads in the region, such as the road from Tongres to Cologne and the road from Aachen to Heerlen.

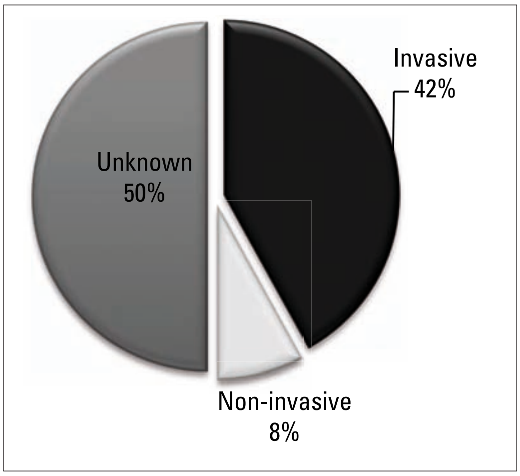


Fig. 4.20. The proportion of sites characterised as 'road network evidence' (category 3), identified by each main type of archaeological activity.

westwards in the direction of current-day Tienen was located more or less under a road still in use today. Because of this, virtually no (invasive) research has been carried out there. On the other hand, many sites were recorded for the main roads located in Dutch Limburg, but in numerous places the road's exact position is still debatable. In addition, a registered item can be anything from a single point in space to a large stretch of road.

The distribution of the 246 items in this category shows a remarkable difference between countries. Map 4.19 shows that the majority were found in the German part of the study area, while very few were located in the Belgian part. One reason for this marked difference is that, in the German Rhineland, the main roads were part of a specific research programme carried out by the LVR. Non-invasive research methods were used to trace the road from Rimburg on the Dutch-German border to Cologne. In Belgium, however, the main road routes have been reconstructed based on limited observations. These suggest that in part the Roman roads lie under their modern day successors. Even though few sites have been examined archaeologically, it is assumed that the routes of the main Roman roads east and west of Tongres are known.

Unfortunately, for a large proportion of this dataset the type of archaeological activity used to identify the site is unknown. This is mostly due to the fact that this information was not included in the infrastructure dataset obtained from the *Ambt fur Bodemdenkmalpflege Rheinland* (ABR). In general it can be assumed that that sites found within the mining areas in the Rhineland were identified through invasive research, and that most sites outside the mining areas were discovered through non-invasive methods such as ground penetrating radar. In the Belgian and Dutch parts of the study area site-identification by non-invasive methods are outnumbered by invasive methods at a rate of 1:5.

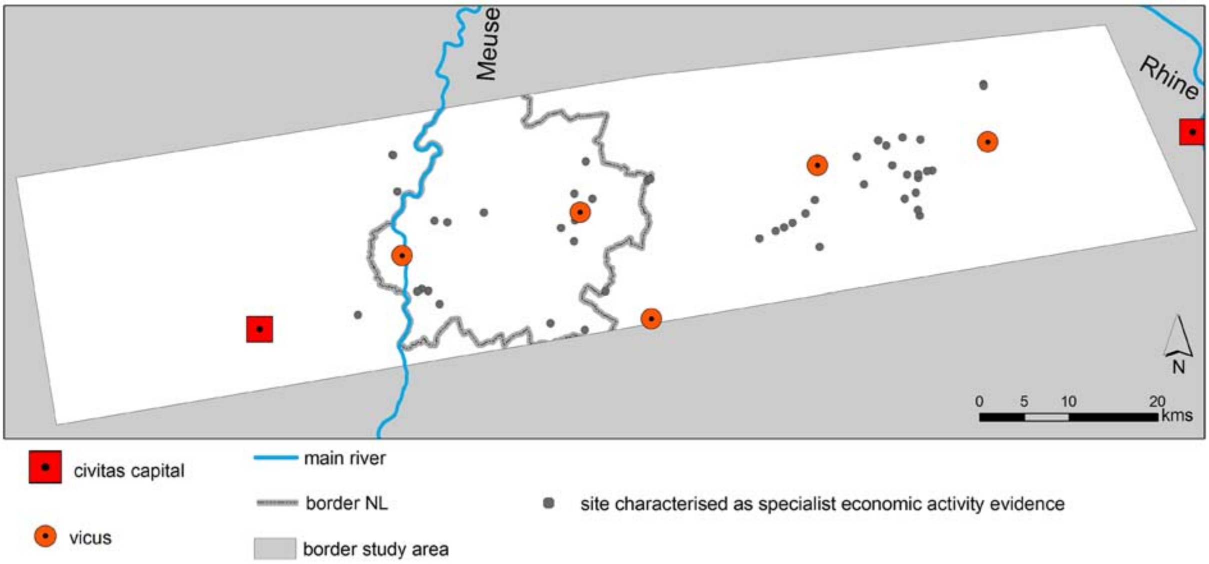


Fig. 4.21. The distribution of points representing specialist economic evidence.

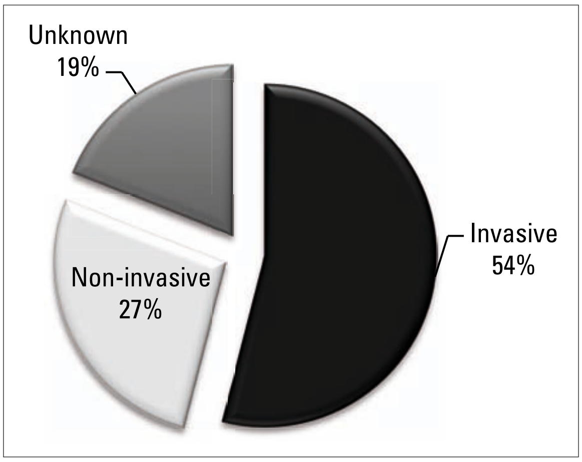


Fig. 4.22. The proportion of sites characterised as 'specialist economic evidence', (category 4), as identified through the main types of archaeological activity.

Road network evidence is notoriously difficult to date, due to the general lack of datable material. In many cases it is hard to even determine whether or not a particular stretch of road is Roman. Not surprisingly, only 3 out of the 264 items were dated beyond the generic 'Roman'.

4.2.4 Category 4: evidence of specialist economic activity

The number of sites that could be identified as representing a specialist economic or craft activity turned out to be quite low. Find materials hinting at craft activities are commonly found within a settlement context, and in moderate amounts. As was pointed out earlier, this category aims to capture evidence of larger-scale economic activities. Therefore it does not come as a surprise that only 48 of the 3047 items in the dataset are classified as category 4.

The distribution map shows that most of the points in category 4 were found in the German and Dutch part of the study area. The lack of this type of site west of the Meuse is remarkable. Whether this is evidence of a real situation in the Roman period or the result of differences in archaeological practices remains to be seen.

Perhaps unsurprisingly, the majority of sites in this category were identified through invasive research (26, or 54%); the remaining items were the result of non-invasive methods (13, or 27%). For 9 sites the method used was unknown.

Dating sites that fall into category 4 can be just as difficult as dating a site in category 3. Unless the remains of a particular product was found at a site, for example pottery from a kiln, it is often difficult to find conclusive evidence to date a site in this category to the Roman period. Consequently, 38 out of the 48 items in this category cannot dated beyond the generic 'Roman-undefined'. The 10 dated items are from the middle Roman (2), middle to late Roman (2) and late Roman period (5), plus one site dated early to late Roman period. Although it is difficult to draw any conclusions from such a small proportion of the dataset, the numbers seem to suggest a pattern in which the development of specialist economic activities did not take off in the study region until the end of the first century AD.

4.2.5 CATEGORY 5: EVIDENCE OF SPECIFIC ROMAN FEATURES

What applied to category 4, also applies to the evidence of the type of specific Roman features defined for category 5. In order to reliably identify a *horreum*, sanctuary, aqueduct or *burgus*, archaeological evidence in the form of plans are necessary, and this can only be obtained through an excavation. It is unsurprising, therefore, that of the 92 sites in category 5, 70 were the result of an excavation.

Unfortunately, even with such a high number of excavated sites, dating information for 64 sites, corresponding to 70%, does not suggest much above sites being 'Roman'. The 28 more precisely dated sites show markedly different proportions per period compared to the overall dataset, as shown in figure 4.24 below. This could be caused by the fact that certain subtypes of sites in this category are typical of a certain period, such as the *burgus* (late Roman). This will be discussed further at the interpretation of data at level 3.

Compared to the specialist economic activity sites of category 4, the sites of category 5 are quite evenly distributed across the study area, shown in figure 4.25.

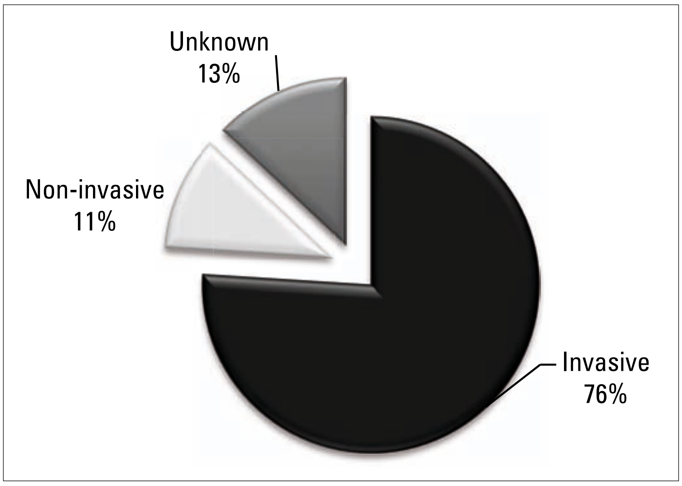


Fig. 4.23. The proportions of sites characterised as evidence of 'specific Roman features' (category 5), identified by each main type of archaeological activity.

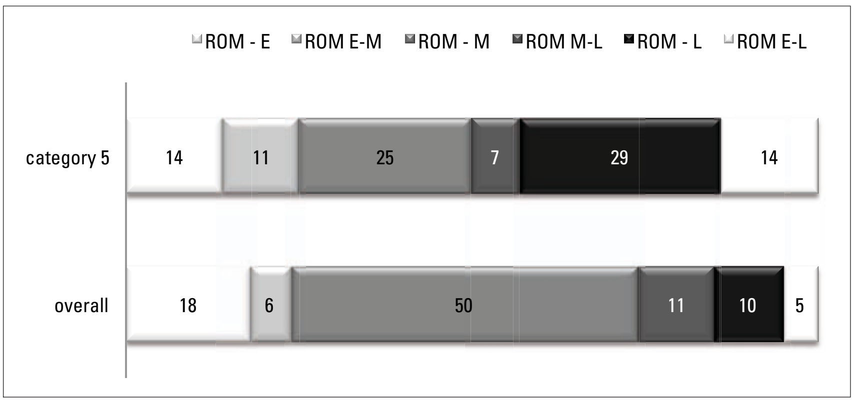


Fig. 4.24. Comparison of the proportion per period of sites characterised as evidence of 'specific Roman features', (category 5), with those of the overall dataset. The numbers represent percentages.

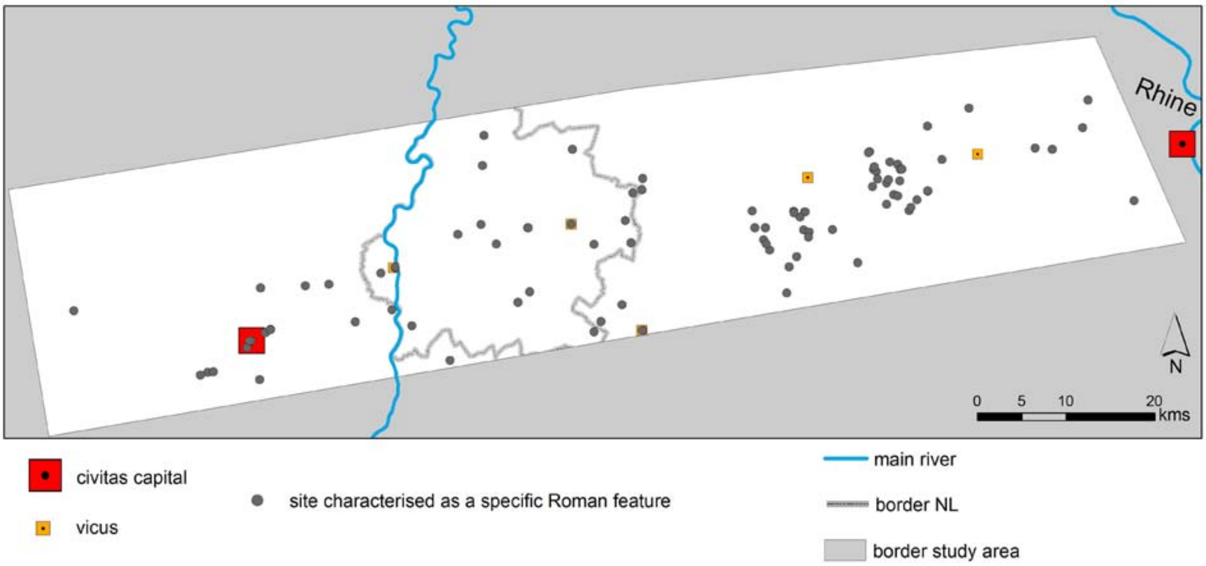


Fig. 4.25. The distribution of points characterised as a specific Roman feature.

4.2.6 CATEGORY 6: INDEFINABLE EVIDENCE

There were 711 remaining items that could not be otherwise categorised according to the criteria set up for this study. The distribution of these points seems quite even, although, proportionally, more sites were found in the Dutch and Belgian areas (33 and 37% respectively) than in the German area (17%).

On examination, it is perhaps surprising to note how few (12%) of the 714 points there are from which no archaeological method can be attached on how they were identified. As the graph in fig. 4.27 shows, one-fifth of these sites were identified by an invasive method, and two-thirds through non-invasive methods. However, the majority of these sites cannot be dated beyond the generic 'Roman period', meaning they provide little information regarding dating. Nonetheless it is believed that with

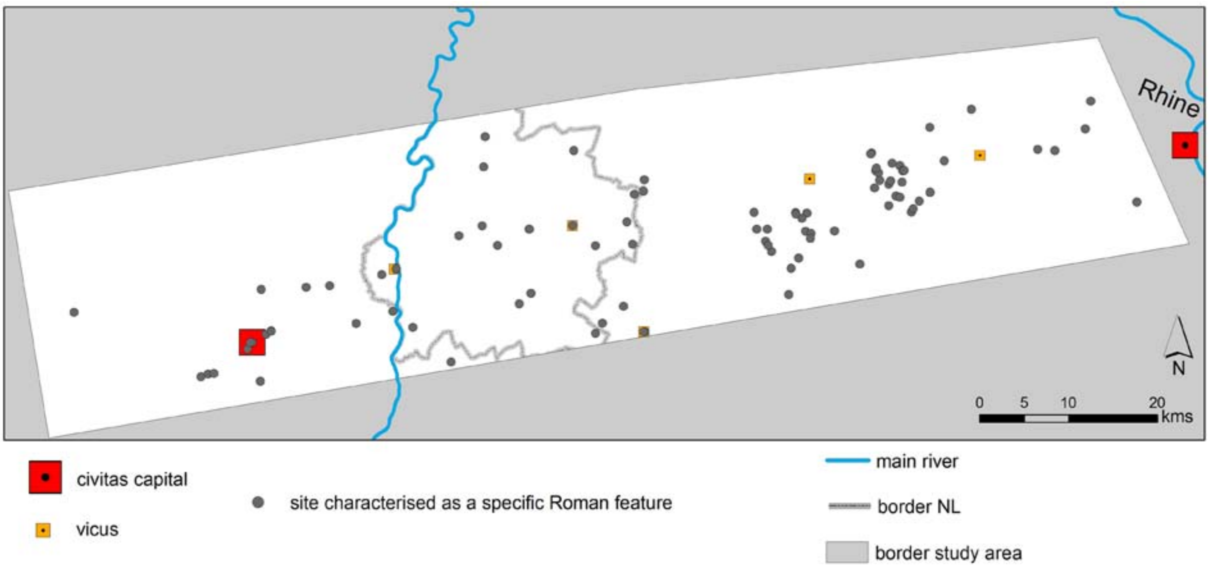


Fig. 4.26. The distribution of category 6 sites with indefinable Roman evidence.

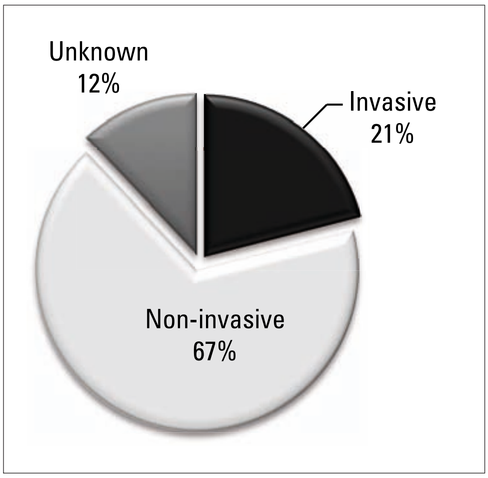


Fig. 4.27. The proportions of sites with indefinable evidence, (category 6), identified by each main type of archaeological activity.

a category of this size it should be explored how it could be of use in the reconstruction of the Roman landscape, an issue examined further in chapter 5.

4.2.7 CONCLUSIONS

To conclude, the data characterisation at level 2 of interpretation provides new insights into the composition and nature of the dataset. It has been shown that the largest category was that of settlement evidence (category 1), followed by the category of indefinable sites (category 6), and funerary practice evidence (category 2). Road networks (category 3), specialist economic evidence (category 4), and specific Roman features (category 6), are represented by much smaller numbers.

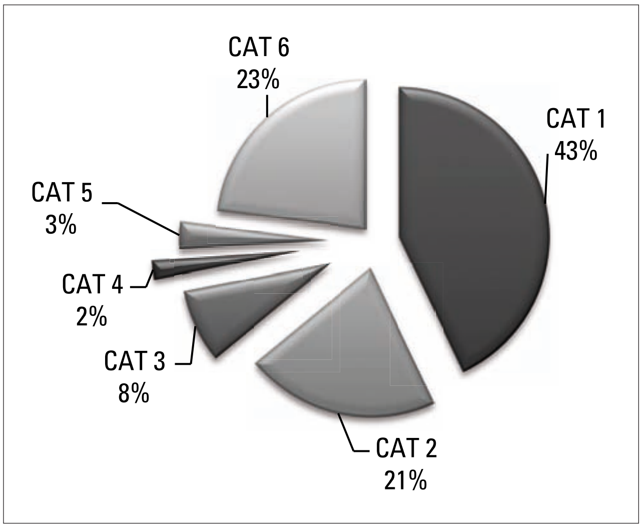


Fig. 4.28. The proportions of the six site categories interpreted at level 2 as used in this study.

Regarding how these sites were identified archaeologically, it has been shown that this varied considerably between categories, as illustrated in figure 4.29. As expected, evidence allowing a site to be categorised as 3, 4 and 5 by nature demanded an invasive archaeological technique, such as an excavation, was used. It is remarkable, therefore, that the proportion of the indefinable sites is exactly the same as those for settlement sites.

The maps showed different patterns relating to the distribution of each type of site. There appears to be a relatively even distribution of sites in category 2 (funerary practice) and 6 (indefinable) across the study area. The other four categories, however, showed a noticeable difference in site density across the region, whereby the area west of the Meuse river had fewer sites than the central and eastern part of the study region. Category 1 (settlement) and 5 (specific Roman features) in particular show higher numbers in the part of the study area covered by modern-day Germany. As shown earlier, the way sites have been identified archaeologically differs from country to country. It could be argued that the distribution patterns are related to differences in national research traditions, rather than a reflection of the actual Roman landscape. This will be further explored in chapter 5.

The last attribute explored by category was the dating of sites. It was established that some categories provided hardly any dating details, such as categories 3 (road network) and 4 (specialist craft). For the categories that did, the overall trend seems to be one of growth and decline, with the majority of sites dated as middle Roman, and decidedly fewer sites dated as early or late Roman. Only a small proportion of all sites showed continuity from early to late Roman.

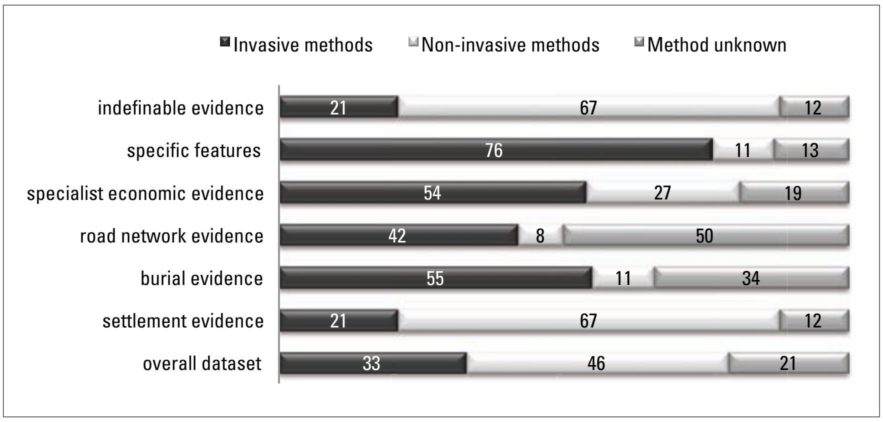


Fig. 4.29. The percentages of each of the six categories of sites identified by each main type of archaeological activity, compared to the proportions for the overall dataset.

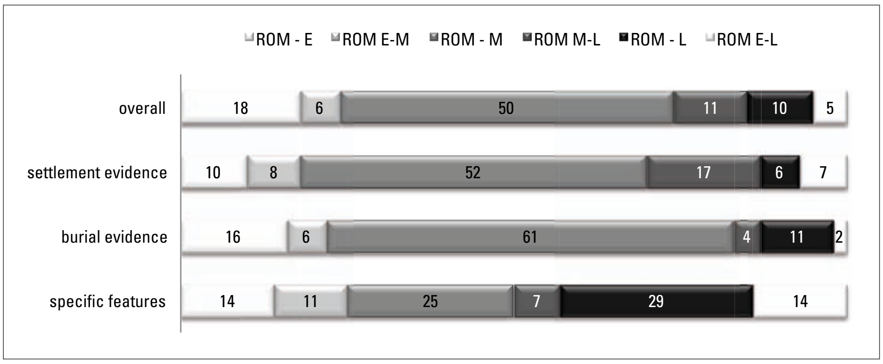


Fig. 4.30. The dating of sites in each category, compared with the overall dataset.

4.3 THE ROMAN LANDSCAPES IN DETAIL

The following is a presentation of the dataset at level 3 of interpretation, the most detailed level of information. Each of the five categories at level 2 will be presented, starting with the category of settlement evidence (category 1).

4.3.1 CATEGORY 1: SETTLEMENT TYPES

One of the main differences between settlements at level 3 is between urban and rural sites. This is because one of the main research questions in this study concerns the introduction of urban settlements in the region.

Urban settlements

As noted earlier, there were 2 *civitas* capitals in the study area, *Atuatuca Tungrorum* and *Colonia Claudia Ara Agrippinensium*. In addition, 11 sites were recorded that complied with the criteria for an urban settlement, consisting of a conglomeration of dwellings. Surprisingly, in addition to the 5 known *vici*, 6 other conglomerated settlements were identified in the region. The extra sites are all located in the German Rhineland. This makes the total number of urban sites 13, their distribution being shown in figure 4.31.

With 13 sites characterised as 'urban', there are 1288 remaining sites that are consequently interpreted as rural, equating to 99%. This means that it can be established that the study area was predominantly rural, with only a very modest urban component. Of these 13 urban sites, two were the capital of their respective civitas: Atuatuca Tungrorum and Colonia Claudia Ara Agrippinensium. These

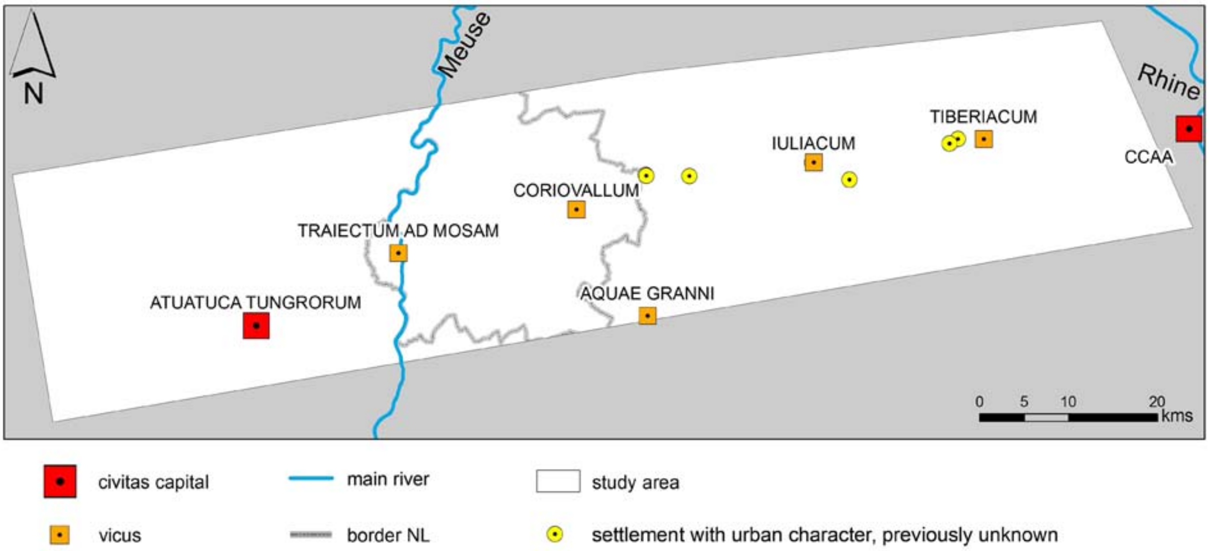


Fig. 4.31. The distribution of settlement sites characterised as 'urban'. The circular symbols are used to mark sites that represent previously unknown settlements with an urban character; in this study these are interpreted as small villages.

towns are dated early to late Roman. The smaller towns, or *vici,* of *Trajectum ad Mosam, Coriovallum, Aquae Granni, Juliacum* and *Tiberiacum* all started in the early Roman period, under August, and were continuously inhabited until the late Roman era. These towns did not have an official status such as *municipium* or *colonia*. With the exception of one (Trajectum) their names are known through written sources such as the Peutinger map.

In addition to the 7 'established' urban sites, there are 6 other sites that were interpreted as 'urban'. These 'new' urban sites differ from the other five known *vici* in that they were not known from any written source or map. Furthermore, their location could be seen as surprising, as they are scattered along the main road between Tongres and Cologne at varying distances between them and between the other towns/villages.

Unfortunately there is no precise dating information available for the 'new' towns. It is therefore difficult to obtain new information regarding the development of the urban landscape from the 13 urban sites, apart from the conclusion that part of this landscape developed without direct involvement of the Roman authorities. But there is another conclusion that can be put forward, based on observations regarding size and lay-out of these urban settlements. It was noted, during the collection of data, that the lay-out of the *vici*, such as *Coriovallum*, differed substantially from the roadside settlements, such as the ones found at Rimburg and Baesweiler, with the latter ones having a long narrow lay-out, and the *vici* being spread more widely. The *vici* themselves were a different shape from the official towns with their quadrangular, grid-like plan. Also, the areas of the different types of urban settlements seems to have been quite divergent. Based on these differences, it is tempting to conclude that there were three different types of urban settlements in the region. On the one hand there were towns, with an official status in the empire, with a grid-like plan, and substantial size. These presumably formed the top of the settlement hierarchy. On the other side of the spectrum was the small road-side village, without any official status, consisting of single rows of houses on both side of the Roman main road. Wedged in between these two types was the *vicus*, a small town, without an official status, smaller than the official towns, but larger than the roadside villages, with a plan that resembled somewhat of a grid. Of course, shape and size alone cannot be seen as sole evidence of the status of an (urban) settlement. Further research into the hierarchy of the urban component of the settlement landscape in this part of the empire is, therefore, necessary to substantiate these assumptions.

Rural settlements

Application of the find material criteria to the 1288 sites considered to be rural resulted in the interpretation of 1247 sites as being of a stone-built-type, and 41 sites of a post-built type. This translates into a proportion of 97% versus 3%. These numbers suggest that the rural landscape in the study area was completely dominated by stone-built settlements, and that the vernacular style of building in the region was replaced almost completely by the Roman-influenced style. Before drawing any such conclusions, however, the possibility of a research bias must be considered. As mentioned in chapter 3, post-built structures can only be identified through invasive archaeological activities. This is backed by the evidence, as 34 of the 41 timber-built sites were the result of an excavation. As the majority of the sites in category 1 were the result of non-invasive activities, the number of post-built sites was certain to be substantially lower than the number of stone-built sites. This issue will be addressed further in the next chapter.

Of the 41 post-built sites, 30 were dated specifically, as were 338 of the 1247 stone-built sites. Looking at the percentages, nearly all post-built sites dated to the early and early to middle Roman period. In contrast, sites that were classified as stone-built predominantly dated to the middle and late Roman period. Table 4.4 shows the exact numbers per period, and figure 4.32 the percentages, for both rural settlement types.

	post-built sites	stone-built sites
early Roman period	19	18
early – middle Roman period	5	23
middle Roman period	5	189
middle – late Roman period	0	65
late Roman period	0	22
early – late Roman period	1	21
Undefined	11	909

Table 4.4 Numbers of sites per specific period per rural settlement type (n=1288).

These results could be interpreted as evidence backing up the assumption that the post-built type of rural settlement was a legacy of the pre-Roman period, being replaced almost entirely by stone-built settlements in the mid-Roman period. This would mean that by the second century AD, post-built farms were unlikely to have been present in the study area. The numbers also indicate that stone-built settlements were present from the beginning of the Roman period, but that their numbers grew substantially over the first century, showing a real 'boom' in the second century AD, before dwindling strongly in the third and fourth centuries. The validity of these claims requires further research.

Rural settlement hierarchy

As discussed in the previous chapter, rural settlement in the study area is usually characterised as being made up of farms built in the native tradition or as a Roman-style villa, the obvious distinction between the two being the use of stone. Villas are also generally seen as the residences of members of the elite, in line with the situation in other parts of the Roman empire. If, however, 97% of all rural settlement sites in the study area were built using stone and ceramic build materials, and these sites are interpreted as villas, it cannot be maintained that they represent the residences of the elite, since, by definition an elite forms a minority within society.

If it is to be maintained that the local elite lived on villa estates, and this elite constituted a minority in society, not all settlements characterised as stone-built should be interpreted as a villa. This suggests a need to find new ways to differentiate the group of stone-built rural settlements. Although it lies beyond the scope of this study to design a new settlement hierarchy, it was thought that an exploration of the possible ways in which the large group of settlements, characterised as 'stone-built',

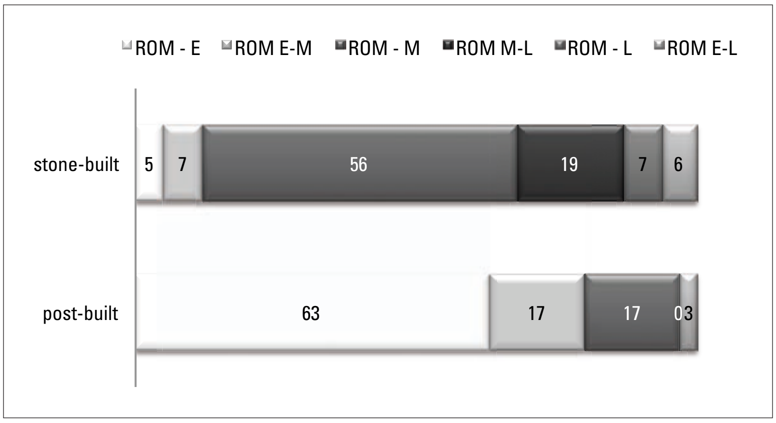


Fig. 4.32. The proportion per period for the two types of rural settlement.

might provide new insight into the important issue of settlement development and diversity in the study area.

In his recent study of Roman villas in the northwest of the empire, Habermehl analyses different characteristics of rural settlements labelled as 'villa', such as the architecture of the main house, and the layout of the settlement.[2] It makes sense to use this information to examine different aspects of the stone-built settlements in this study region. For example, regarding the architecture of the main house, Habermehl identifies four different types: traditional house (TH), Romanized traditional house (RTH), timber-frame house (TFH) and multi-roomed house with stone foundations (MRH-SF). This characterisation shows that between the obviously distinct types of the post-built traditional house and the stone-built multi-roomed house, there are two other types that seem to be a combination of vernacular and Roman elements. For his characterisation, Habermehl uses only completely excavated and published settlements.[3] Of the settlement dataset used in this study, not more than 17% (220 sites) was suitable for characterisation according to house type, because of the detailed information needed to differentiate between the various elements of the settlement. Nonetheless, it was decided to test whether these 220 sites could offer new insights, keeping the obvious restrictions in mind. For the characterisation, the guidelines used by Habermehl were applied to the dataset. Of the 220 suitable sites, 171 were of the type 'multi-roomed house with stone founda-

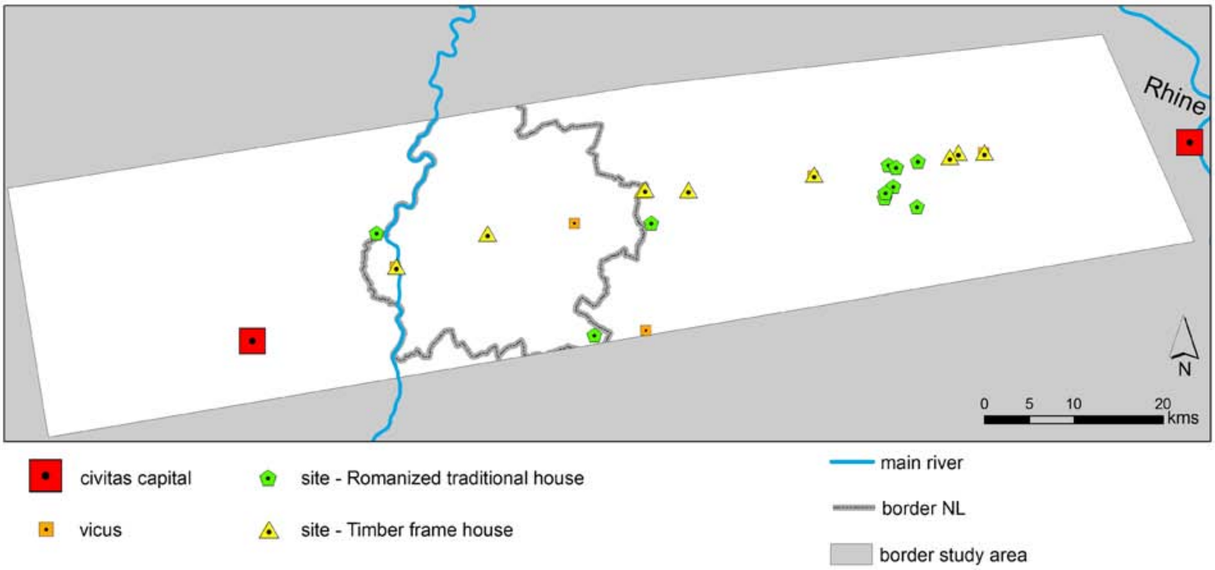


Fig. 4.33. The distribution of the two house types that combine vernacular with Roman-style architecture, as defined by Habermehl.

[2] Habermehl 2011.

[3] In Habermehl's study, the research region is much more extensive than that of the study at hand.

tions', 30 were of the 'traditional house' type, 9 were 'timber frame houses' and 10 were categorised as 'Romanized traditional houses'. These numbers translate into the following percentages: 78% for the MRH-SF-type, 14% for the TH, and 4% each for RTH and TFH. Applying Habermehl's criteria thus results in slightly different proportions regarding the vernacular and Roman-style architecture in the study region, but obviously the traditional house remains overwhelmingly outnumbered by the multi-roomed house with stone foundations. Regarding the types of houses with mixed elements, the distribution map shown in figure 4.33, shows that the timber frame house is found mostly in the road-side villages and *vici*, whereas the Romanized traditional house is found predominantly in rural settings.

Habermehl also used a classification based on the layout and organisation of the entire settlement.[4] He distinguished five types: the axially organised settlement, the large organised enclosed compound, the open multi farmstead settlement and the enclosed multi farmstead settlement, and, finally, the single farmstead. Only 142 sites in the settlement dataset of this study provided the necessary details for this classification, a result of the fact that most rural stone-built sites in the study area are not examined outside of the main building. Details concerning the enclosure of a settlement are often such that no reliable verdict can be reached regarding its character (open or closed) and therefore the multi-farmstead types have been grouped together for this dataset.

Of the 142 sites, 104 (73%) were characterised as being a large organised enclosed compound, 24 sites (17%) as multi-farmstead settlements, and 14 sites (10%) as single farmsteads. Interestingly the fifth type in this category, the axially organised settlement, although quite common in some parts of *Gallia Belgica*, is lacking completely in the study area. These results show that, although the characterisations regarding house type and settlement type do provide new insights into the (rural) settlement category in general, it does not shed light on the issue regarding the supposed 'elite' status of (part of) the stone-built settlement sites. Therefore, a third variable used by Habermehl, relating to the size of the main house in a stone-built rural settlement, is examined. His study distinguishes between houses that had less than 10 rooms, houses that had between 10 and 30 rooms, and 30+ roomed houses.[5] Obviously for this characterisation, detailed information regarding the main house was necessary, and only 51 sites in the study area provided sufficient information.

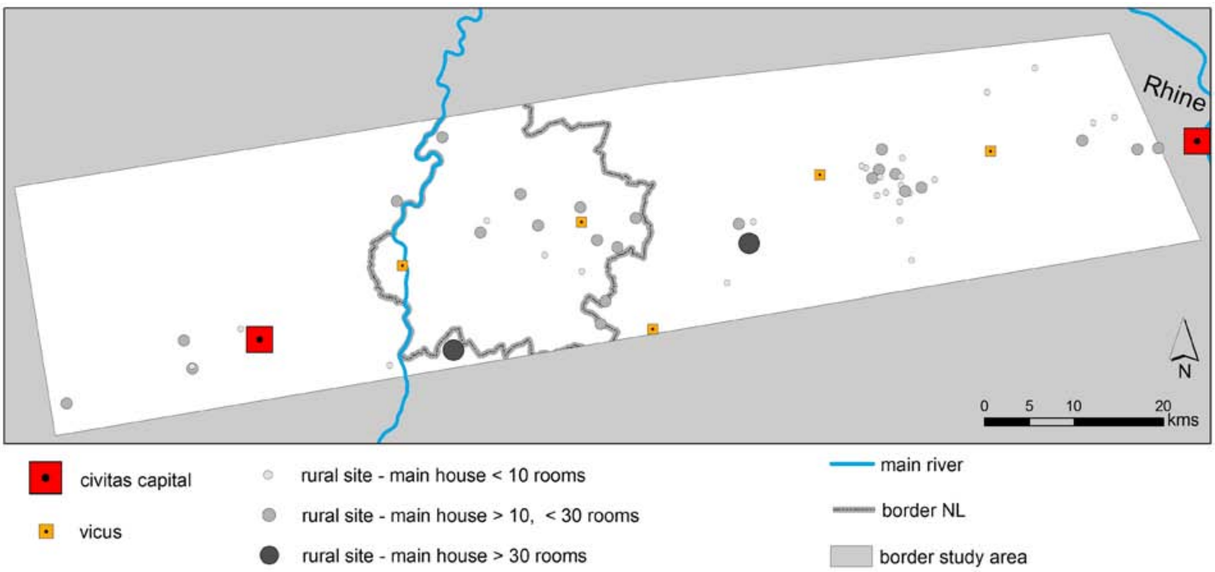


Fig. 4.34. The distribution of the 58 rural sites characterised according to their number of rooms.

[4] Habermehl 2011.

[5] Habermehl 2011.

Of these 51 sites, 25 belonged to the 'less than 10 rooms' category and 24 to the '10 to 29 rooms', with only 2 sites in the study area being of the 'more than 30 rooms' house type. In other words, the variable 'number of rooms' allows for a subdivision of stone-built rural settlement sites into small, medium and large houses, whereby small and medium-sized houses were the more common type of rural dwelling in the study area, with almost equal numbers. Interestingly, the large 'palatial' type, usually associated with the term villa, appears to have been almost completely lacking in the region.

The distribution of the different sites (see figure 4.34) shows that there is no obvious clustering of any one type in the study area, as both the small and medium-sized houses were found throughout the region.

To conclude, use of Habermehl's classifications has resulted in new information regarding the (stone-built) settlement types. If the numbers obtained can be considered as representative of the Roman settlement landscape, the average stone-built rural settlement on the loess soils between Tongres and Cologne was a large organised enclosed compound, with a small to medium-sized multi-roomed house, built on stone foundations. Nonetheless, more convincing evidence is needed with regard to establishing the residences of the local elite. It is proposed here to follow the method of another researcher working with Roman settlement differentiation. In her work analysing Roman settlement in Languedoc, France, Nuniger proposed a methodology for settlement hierarchy based on the presence or absence of particular types of material evidence. Evidence of decorative elements, such as painted plaster, mosaics, and precious natural stone such as marble, is seen as indicating a high status site.[6] Using this form of interrogation, specific architectural elements, such as a hypocaust, or a private bath house, can be interpreted as characteristic elements of the 'classic' Roman villa and, arguably, the opulent life style of its inhabitants. Thus, if it could be established what proportion of the dataset had evidence of such elements, more information could be provided as to a possible hierarchy within stone-built sites in the study area. As reliable evidence for these elements is limited to excavated sites, only part of the dataset of this study could be analysed. The material evidence itself poses problems. First of all it is likely that the most valuable materials were removed from the remains of a house, to be reused elsewhere. Absence of this material at a site might not mean it was not there originally. Futhermore, although fragments of *tubuli*, *tesserae*, or painted plaster can be found during a field survey, it may not always be recognised for what it is. Therefore they are likely to be reported as generic 'ceramic building material' or 'plaster' (if mentioned at all).

Within the study area, 172 excavated rural stone-built sites provided sufficient information to be used with this characterisation. Of the 172, 46 had evidence of a hypocaust, which corresponds to 27%; 33 sites had evidence of a private bath house, which corresponds to 25%, and only 15 sites had evidence of rich decorations in the form of painted plaster, mosaics or decorative natural stone, which corresponds to 23%. When analysing the sites for a combination of the three elements mentioned above, 12 sites or 25% had one of the three elements, 30 or 61% had two of the three, and only 7 or 14% had all three elements. Without jumping to any conclusion, these lower percentages seem to be a better reflection of a more affluent minority that would be expected for a hierarchy.

The distribution maps (figs. 4.35-4.37) show that, some regional differences notwithstanding, the sites with evidence of these specific elements are quite evenly spread over the entire study area, i.e. it is difficult to identify a particular area with substantially higher numbers of any one element. A possible exception are sites showing evidence of decorative interior elements such as painted plaster, of which several were located on modern day Dutch territory.

The next obvious step was to combine the results of the classifications by Habermehl and Nuniger. Of the sites characterised as having a 'medium-sized main house', only 4 showed evidence of a hypo-

6 Nuniger 2003, 71; see also Bertoncello / Nuniger 2005, 9-10.

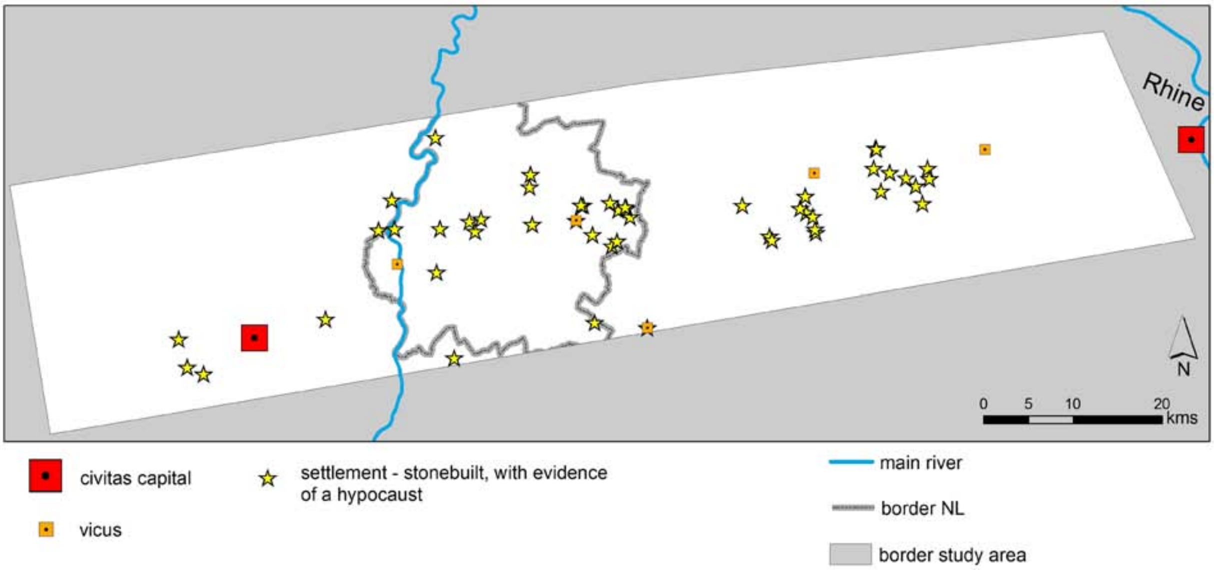


Fig. 4.35. The distribution of the 46 stone-built settlements with evidence of a hypocaust.

Fig. 4.36. The distribution of the 33 stone-built settlements with evidence of a private bath house.

caust, baths, and rich building materials; 3 sites did not have evidence of a hypocaust, baths or rich building materials. Interestingly, of the sites classified as having a 'small main house', 3 had evidence of a hypocaust, 1 site had baths, and 1 site had evidence for rich building materials. It is therefore important to conclude that the relations between the type and size of the main house and its architectural elements are far from straightforward. Smaller houses could have had more 'luxurious' elements, and bigger apparently did not always mean better.

It is hoped that this exploration of stone-built sites has demonstrated the usefulness of analysing different variables of the settlement dataset. By exploring part of the dataset, information was obtained regarding the size of the main dwellings, the organisation of the settlement and the presence of typical 'wealthy' Roman-style architectural elements as a hypocaust, private bath house, and ostentatious

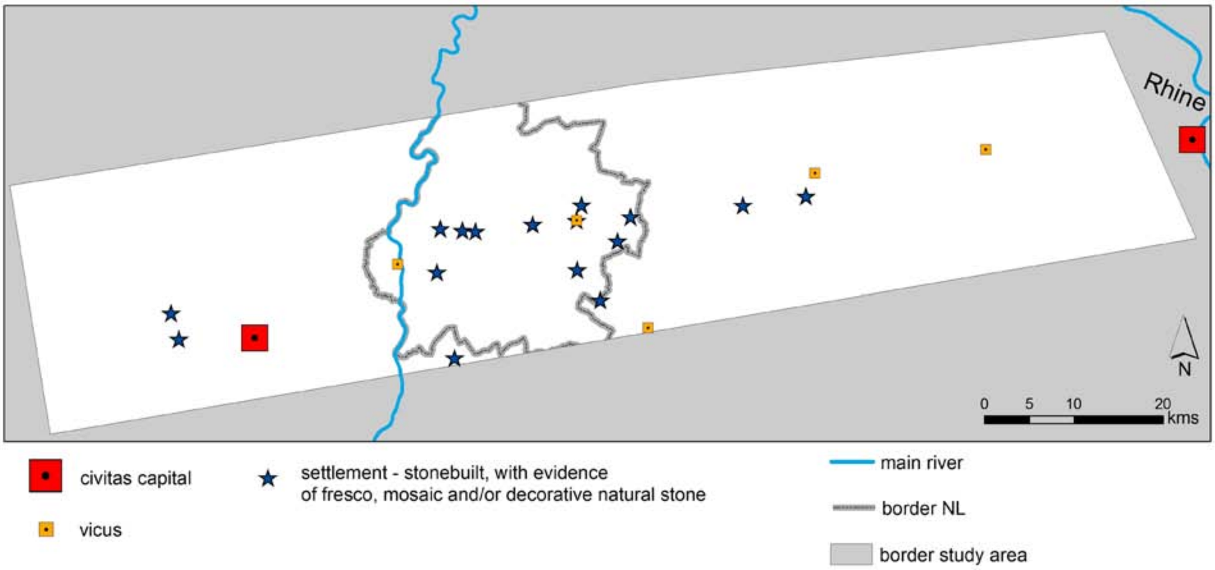


Fig. 4.37. The distribution of the 15 stone-built settlements with evidence of frescoes, mosaics or decorative natural stone.

decorations such as mosaics and frescoes. If the subsets are considered to be representative samples of the entire settlement dataset, these results hint at differentiation within the subcategory of stone-built rural sites, indicating that one tenth to one quarter of them stand out for being more conspicuous regarding the architecture of the main house. Whether or not these sites should be considered as residences of the higher echelons of Roman provincial society in this part of the empire is the obvious question; one that I do not feel comfortable answering at this point. What I do want to point out is that if the appearance of the main house is considered to be a reliable indicator of the status of its inhabitants, the results of the analysis suggest a considerable variety in the status of villa-owners. This could be taken as an important clue to the composition of the society in this part of the empire. In any case these results form conclusive evidence against the monolithic interpretation of stone-built rural sites as a single type of settlement, automatically associated with 'the elite'. To further explore this issue and substantiate the claims made above more fully, new empirical data regarding this issue is necessary.

4.3.2 Category 2: Types of funerary evidence

Evidence of Roman funerary practices in the study area were firstly divided into two main groups at level 3: regular and monumental. Regular evidence consist of the cremated or inhumated remains of a person, with or without a container, with or without grave goods, placed in a pit in the ground. The term 'monumental' is used to describe funerary sites with exceptional material evidence, in the form of an oversized grave marker above ground, and/or a large (stone) container underground, with an abundance of, often luxurious, grave goods.

Of the 646 sites in this category, 493, or 76%, were characterised as regular funerary evidence, meaning a quarter of all burial sites was interpreted as monumental evidence. These numbers are skewed, as the number of regular burials is in fact higher, because independent burials belonging to the same cemetery were recorded as a single funerary site. Outside of the major *vici,* for example, cemeteries lined the main road(s), and even though they consisted of numerous individual burials, in this study they were recorded as a single funeral site, belonging to the settlement.

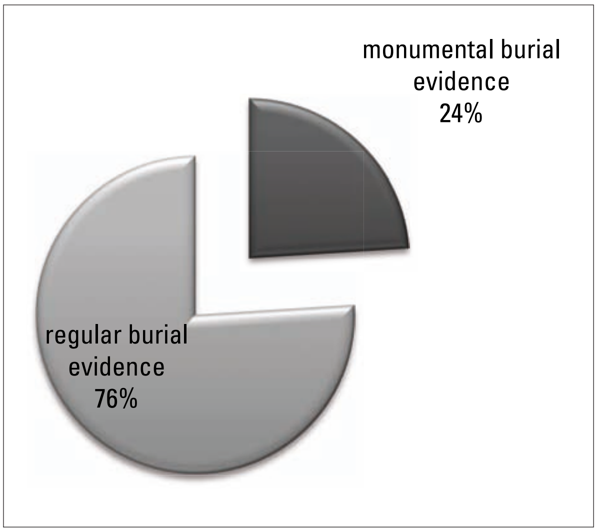


Fig. 4.38. Proportions of regular and monumental funerary evidence (n=646).

Monumental funerary evidence is generally ascribed to the members of the highest rank in Roman society,[7] and the fact that only one quarter of all burial evidence is characterised this way seems to substantiate that assumption.

The distribution map of these two main types of funerary practice sites, in figure 4.39, shows that a large number of monumental burials have been found west of the Meuse. This is remarkable especially because regular burials seem to be less commonly found here. To explain this pattern, the archaeological method through which the data was collected needs to be examined.

For the subset of 493 points identified as regular funerary evidence more than 50% were obtained by means of invasive research (256), whereas only 6% were the result of non-invasive research. For a substantial number of sites (205) information about the nature of the archaeological activity was not provided. The distribution map below demonstrates that the majority of the points on Dutch territory were the result of invasive methods, and that for many of the sites in the German Rhineland the activity is not known. The few sites located west of the Meuse in the Belgian part of the study area are predominantly the result of invasive activities.

The distribution map for sites characterised as monumental burial evidence shows a markedly different pattern, compared to that of the regular burial sites. It can be seen that, even though invasive methods have identified 99 out of 153 sites, or 65%, west of the Meuse, non-invasive methods have still produced a

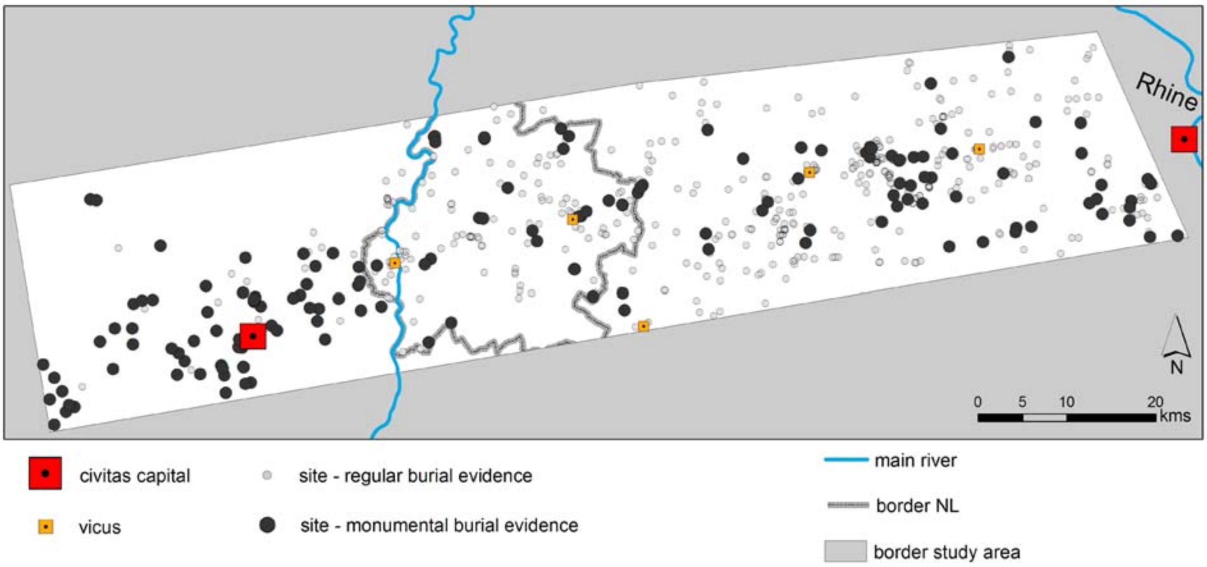


Fig. 4.39. The distribution of 646 sites with regular or monumental funerary evidence in the study area.

[7] There is a wealth of literature available on the subject. For an overview, see f.e. Crowley 2011.

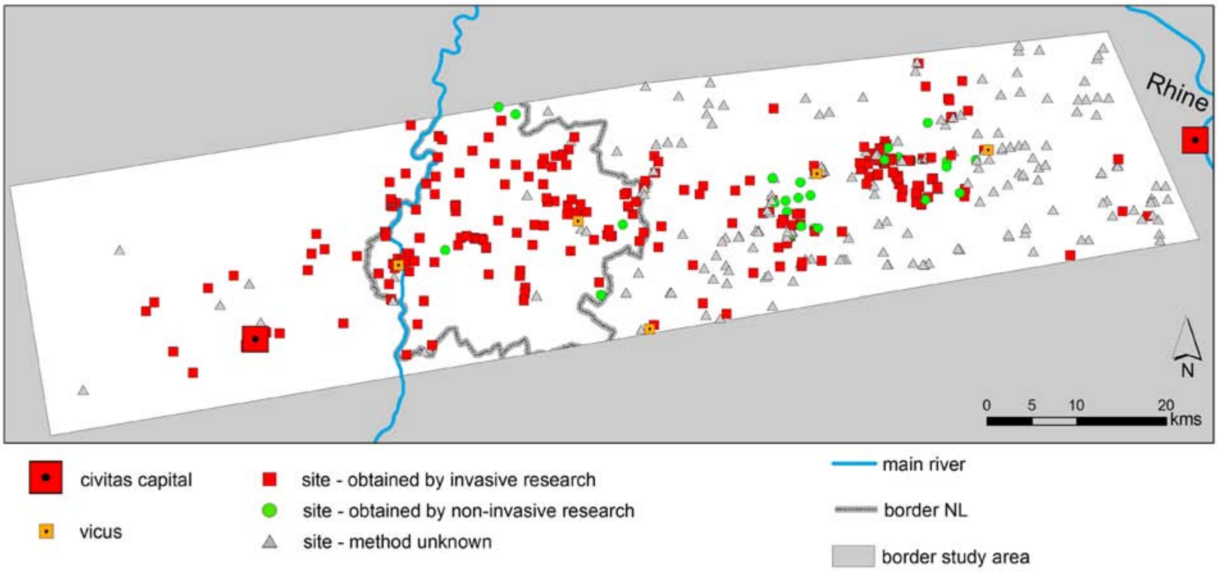


Fig. 4.40. The distribution of the 493 regular burial sites, visualising the attribute 'type of research'.

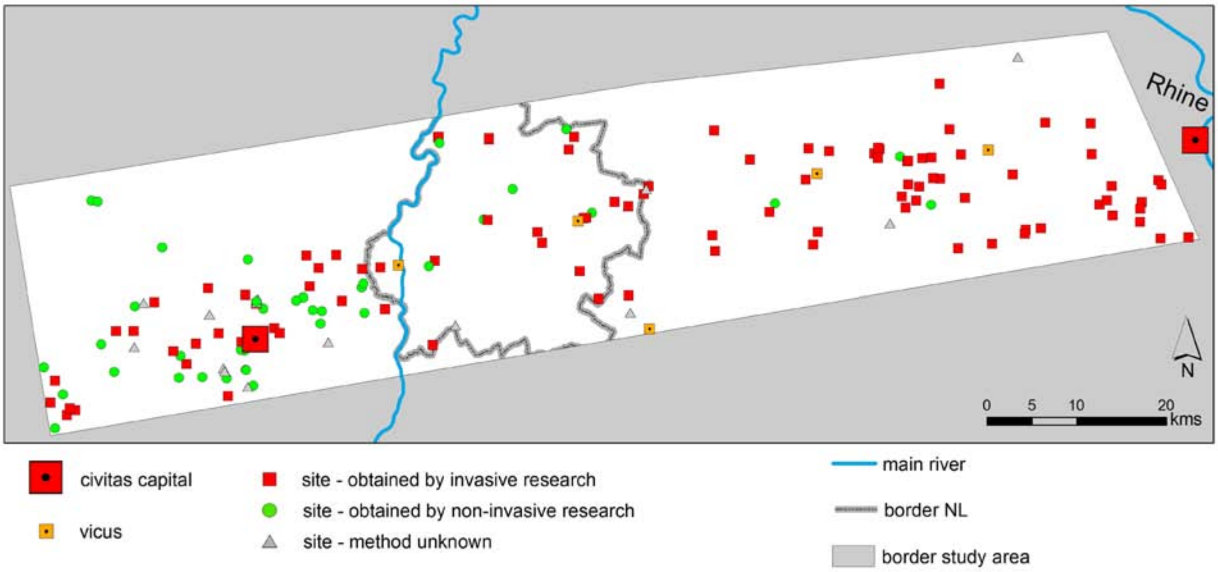


Fig. 4.41. The distribution of the 153 points with monumental funerary evidence in the study area, visualising the attribute 'type of research'.

total of 39 sites, 25%. Apparently, the type of archaeological activity does not explain the observed differences in the distribution of monumental burials, and therefore this subset needs to be further examined.

Types of monumental funerary evidence

Chapter 3 explained that three types of monumental funerary evidence are distinguished in this study: *tumuli*, monumental stone grave markers, and large stone incinerary urns. In total, 76 *tumuli* were recorded, 59 sites with large stone incinerary urns, and 18 sites with the remains of monumental stone grave markers. This corresponds to the percentages shown in figure 4.42.

As with the different settlement types, it can be argued that these numbers reflect a bias due to the nature of the different types. The high number of *tumuli* in the region is undoubtedly because

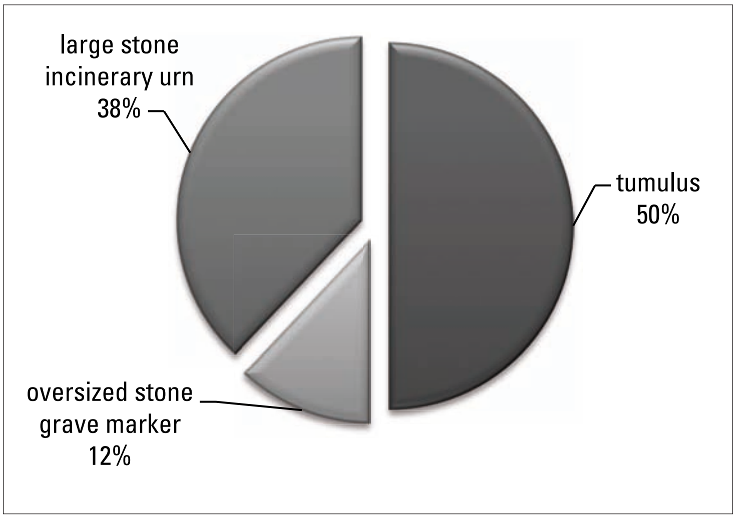


Fig. 4.42. The proportions per type of the 153 sites recorded as monumental funerary evidence.

they are located above ground and are, therefore, discernable with the naked eye. This means that, in general, they do not require any type of archaeological activity to locate. Although large stone incinerary urns do turn up accidentally every now and then, for example during ploughing activities, they are usually located under the surface and therefore require invasive archaeological research. The oversized grave markers are the most difficult to retrieve, because of the fact that most of the above-ground evidence has disappeared; this could be a possible explanation for the low number of this type of monumental burial.

The distribution of the monumental burial evidence is in marked contrast with both the settlement evidence and the regular burial evidence, as clusters of the three different types are clearly visible as shown in figure 4.43.

The map shows that west of the river Meuse only *tumuli* are found. By contrast, this type of monumental burial is almost completely absent between the Rhine and the eastern border of Dutch Limburg, where large stone incinerary urns and, to a smaller degree, Monumental stone grave markers seemed to have been the dominant type. In the area covered by modern day Dutch Limburg all three types of evidence have been found. However it must be mentioned that, of the 9 sites characterised as *tumuli* in this part of the study area, two were of medium reliability, and the remaining 7 of 'low

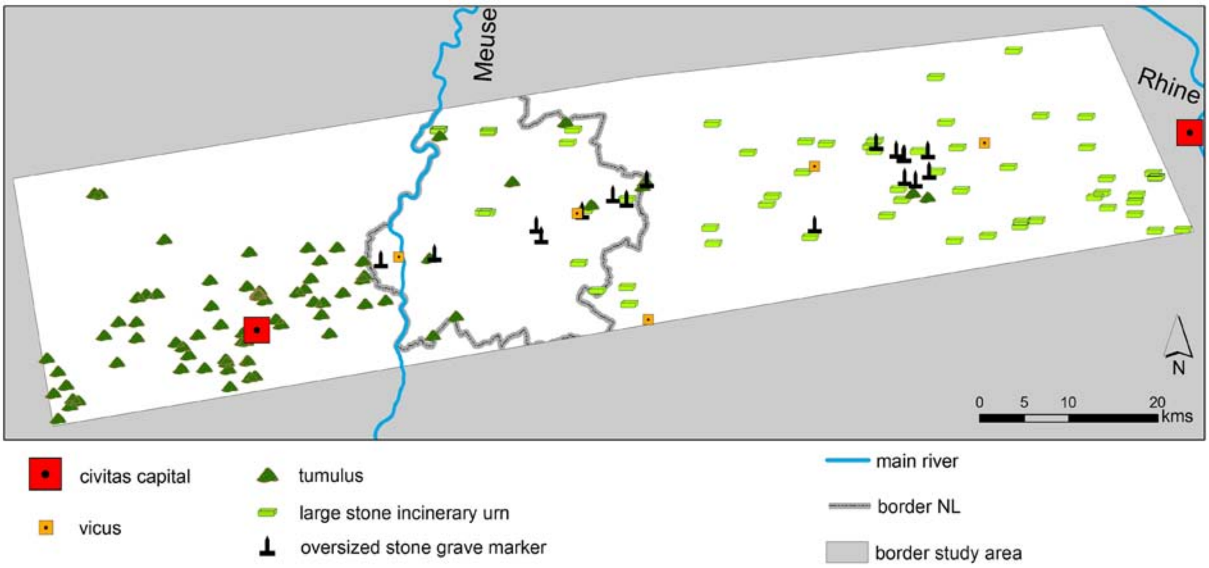


Fig. 4.43. The distribution of the 153 points with monumental funerary evidence, visualising the three subtypes (tumulus, large stone incinerary urn, and stone grave marker).

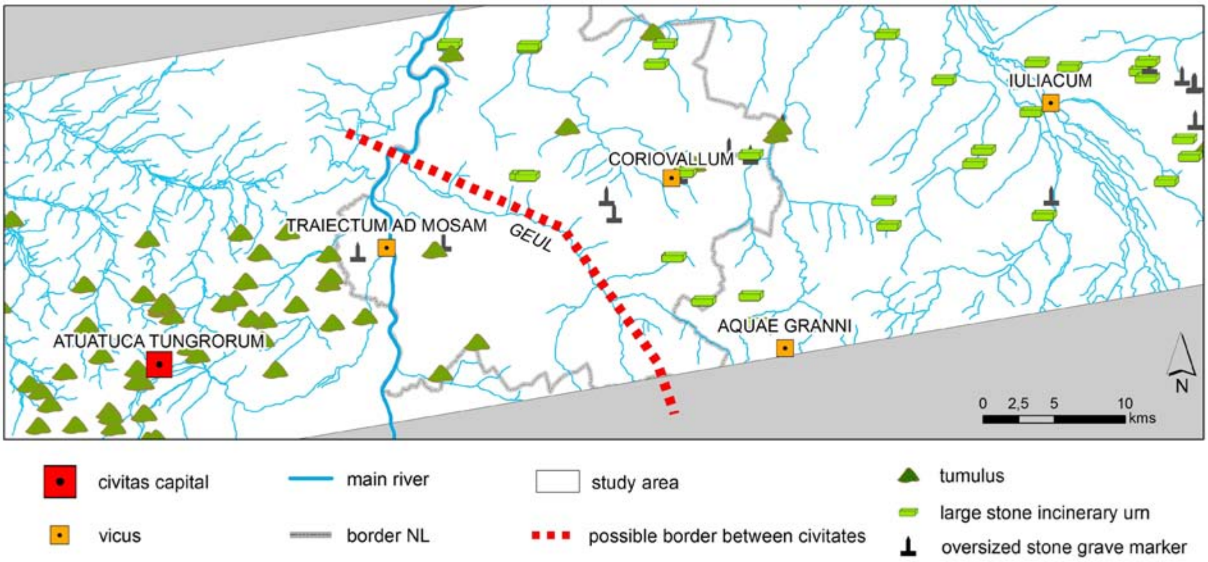


Fig. 4.44. The distribution of the three types monumental funerary evidence, in relation to the river Geul, the assumed border between the *civitas Tungrorum* (with *tumuli*) and the *civitates Traianensis* and *Agrippinensis* (with large stone incinerary urns and stone grave markers).

reliability', because no reliable information was available concerning the remains or the method of archaeological research that identified them. The 9 *tumuli* on Dutch soil are therefore questionable. Nonetheless, this pattern is highly interesting, because it illustrates three issues.

First of all, the pattern in types of monumental burial could reflect the division of the study region into the three *civitates,* that of the *Tungri*, the *Ubii* (later the *civitas Agrippinensis*) and the *Cugerni* and *Baetasii* (later the *civitas Traianensis*). In chapter 2 it was discussed that according to some, the river Geul formed the border between the land of the Tungri and that of the other two civitates. The distribution map of monumental funerary evidence follows this division almost perfectly. Although it can be disputed whether particular monumental burial types are connected to the ethnicity of the people living in the three different civitates, the maps in figure 4.43 and 4.44 suggest a division of some sort between the land west and east of the Meuse, and also possibly between the land east of the Dutch border and the land within it. As Taylor pointed out, *'choices of material expression are decisions that are specific to each social context'*;[8] therefore spatial patterns regarding monumental burials could reflect deliberate choices made by groups of people within a particular area; this makes the observed pattern highly significant.

Secondly, it is now clear why differences in archaeological practices in the three countries did not explain the observed pattern of monumental burials. The morphological differences between *tumuli*, that remained visible above ground after the Roman period, and large stone incinerary urns and oversized gravemarkers, that disappeared over time, are the main cause of the patterns shown in figure 4.40.

The third issue highlighted by the distribution of the distinct types of monumental burials is that it seems to contradict the observation highlighted by the settlement evidence that there did not seem to be a specific pattern of settlement type for any particular area within the study region. Whether the settlement site is analysed in terms of layout, main house size, type of building material, or for the presence of certain architectural elements, the distribution maps showed that different types of settlements all seemed to be present throughout the study area, with no apparent clustering of any specific type.

8 Taylor 2007, 9.

The fact that the monumental burial evidence showed a significant pattern of clustering of a specific type is therefore remarkable and should be the subject of further research.

Dating funerary evidence
Of the 493 points with regular burials, 133, or 27%, have been dated specifically to a certain period. In comparison, 46, or 30%, of the 153 monumental burials, have provided dating details. This need not be surprising, as many of the regular burials were not investigated archaeologically, being found in the period prior to WWII, often during construction or farming activities. The fact that so few burial sites, regular ad monumental, are dated precisely is all the more disappointing because in many cases this type of evidence could potentially offer good dating information, in the forms of grave goods, such as intact pottery, metal objects, and sometimes even coins.

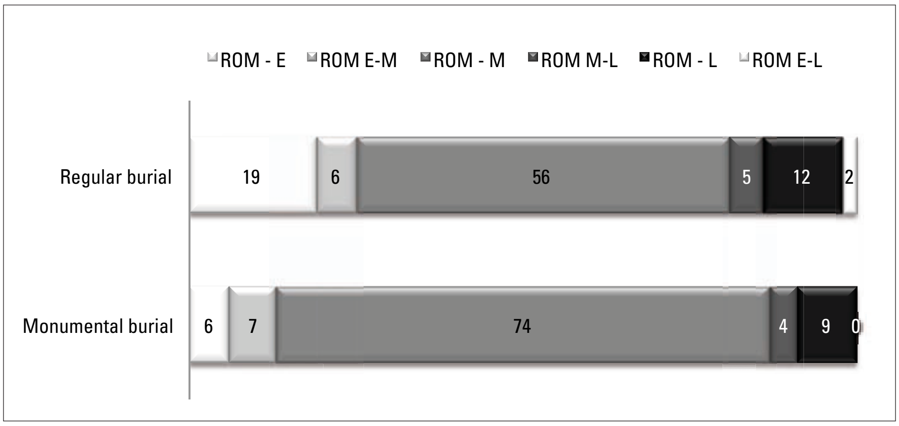


Fig. 4.45. Proportions of the two main subtypes of funerary evidence per period.

When the proportions per period are compared for the two main types of burials, the following pattern can be discerned. Almost 20% of the dated regular burials can be attributed to the early Roman period, compared with only 6% of the monumental burial sites. In contrast, 74% of all dated monumental sites are attributed to the middle Roman period; for regular burials it is just over 50%. Few burial sites are dated as late Roman, although the proportion of regular funerary evidence is slightly greater than that of monumental sites. The fact that, proportionally, the monumental burials show the biggest increase in the middle Roman period could be the result of a development of accumulated wealth in the study area, whereby a substantially larger part of the population saw a significant increase in personal wealth, of which they chose to spend part of it on (expensive) funerary material. However, the fact that only one quarter of all burial sites, regular or monumental, provided detailed dating information, means that the result of any analysis performed with this dataset should be treated with caution.

4.3.3 CATEGORY 3: ROAD NETWORK TYPES

Of the 246 sites characterised as a road network site, 94 were interpreted as evidence for main roads, 144 as evidence for a road in general without any further details ('road – undefined' in this study), and 8 as evidence for a bridge.

A Roman main road in this part of the empire is recognisable by its size (8 to 9 metres wide for the paved road; additional 8 metres of unpaved pathway on both sides of the paved road), and the material used for pavement (using locally available stone, often pebbles, cemented together with loam). To establish its width, the evidence must consist of a cut through the entire road body. Only then is it possible to determine with sufficient reliability the presence of a main road.

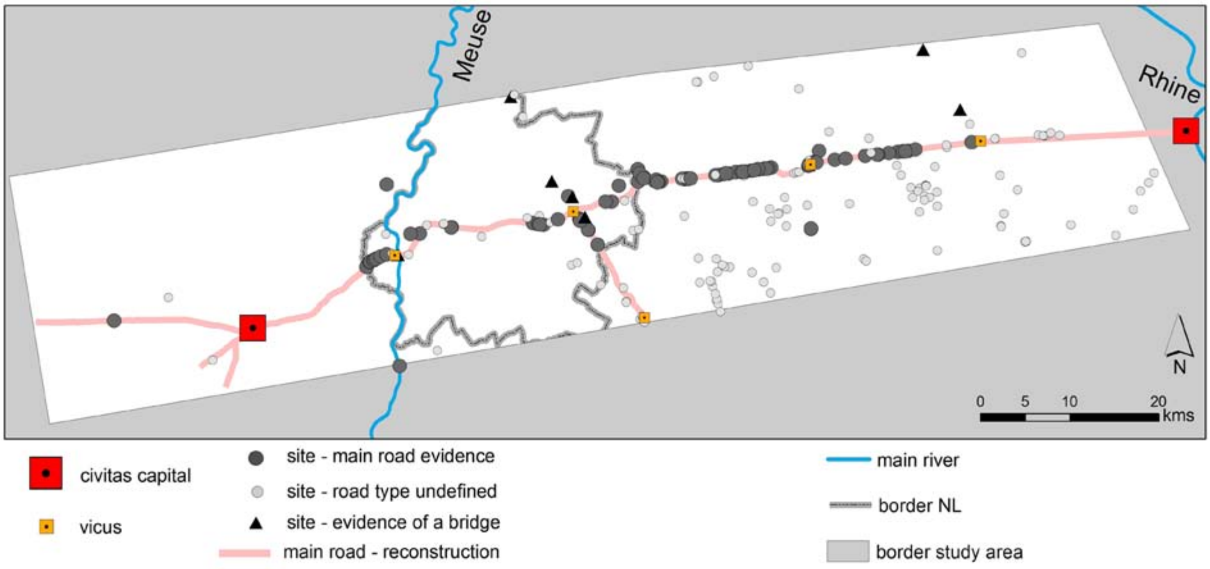


Fig. 4.46. The distribution of the three types of road network evidence.

A second category of road network evidence are the secondary roads. These can be paved, in which case their width did not exceed 4 metres, or unpaved. Evidence of these roads is sparse. These roads were classified as 'road-undefined'. Sites where researchers found remains of a paved road, without any details concerning its width, were also registered as 'road-undefined'.

Evidence for a Roman bridge consisted of wood or stone foundations of bridge columns, as only the material found in the riverbed remained. The wood must be dendro-chronologically tested in order to ensure a date in the Roman period.

The distribution map of the road network evidence (figure 4.46) demonstrates that most sites interpreted as 'main road evidence' were located on the route between Atuatuca Tungrorum and Colonia Claudia Ara Agrippinensium. It is, therefore, hardly surprising that few other main roads running through the region could be reconstructed accurately, particularly roads orientated in a north-south direction, such as the road from *Coriovallum* (Heerlen) to *Colonia Ulpia Traiana* (Xanten). Unless substantial evidence, preferably obtained through excavation is obtained for these other routes, their exact location will remain open to speculation.

Evidence for a bridge was found at eight locations. The most impressive example being the bridge at Maastricht across the Meuse; the seven other bridges are much smaller structures, used for crossing brooks like the Worm, or for crossing swampy territory, like the land surrounding the *Geleenbeek*, just west of Coriovallum. Unfortunately most of these structures were discovered by chance and the resulting information about them is limited.

In general, information for secondary roads was lacking in the study area, particularly in Dutch and Belgian Limburg. Several sites regarding this type were available for the German part of the study area, with one outstanding example of a stretch of nearly 2 kilometres of an unpaved road located in the Hambach region, where it winded its way between several stone-built rural settlements, all situated approximately 500 to 1000 meters away from it. It ran in a southwest – north-east direction, and probably joined the main road from Tongres to Cologne. Interestingly, this road is not straight, nor does it run parallel to the main road or approach it from a straight angle. Unfortunately it also seems to be the only well-examined example in the entire region. As it is understood that rural settlements were producing goods for an external market,[9] it should be expected that they should be physically connected to the main road network in the region. It is disappointing to conclude that virtually no data exists for testing this assumption, and therefore it is impossible, at this point in time, to provide any reconstruction of the transportation networks on a micro regional level. It must be concluded that, based on the current dataset, reconstructing the complete logistic situation of the region is a challenging, if not impossible, task. This is especially true when looking beyond the scale of the main roads. It is made even worse by the fact that there is very little specific dating information for these features, so producing a detailed developmental history of the logistic system in the region is, for now, an impossible undertaking.

4.3.4 CATEGORY 4: TYPES OF EVIDENCE FOR SPECIALIST ECONOMIC ACTIVITIES

Out of the 48 sites in category 4, 13 were identified as locations where pottery was produced at a considerable scale. The main evidence for this type of classification was the presence of kilns. It is remarkable that only one *vicus* in the region can be regarded as a true pottery production centre, that is *Coriovallum,* where more than 50 kilns have been found. Of the 13 pottery production sites, seven were identified through an invasive archaeological method, two by a non-invasive method, with the identification method unknown for the remaining 4. Only three of these sites could be dated to a specific period; two to the middle Roman period and one to the late Roman period.

In addition to the 13 sites regarded as production centres for pottery, 27 others were interpreted as workshops where other products, such as glass or metal were made. 16 of these were excavated, eight were discovered by non-invasive methods, with the identification method being unknown for the remaining three. For six sites a date for a specific period was given, one in the middle to late and five to the late Roman period. In most cases these late Roman workshops produced glass. All of these glass-production sites were located in the German part of the study area.

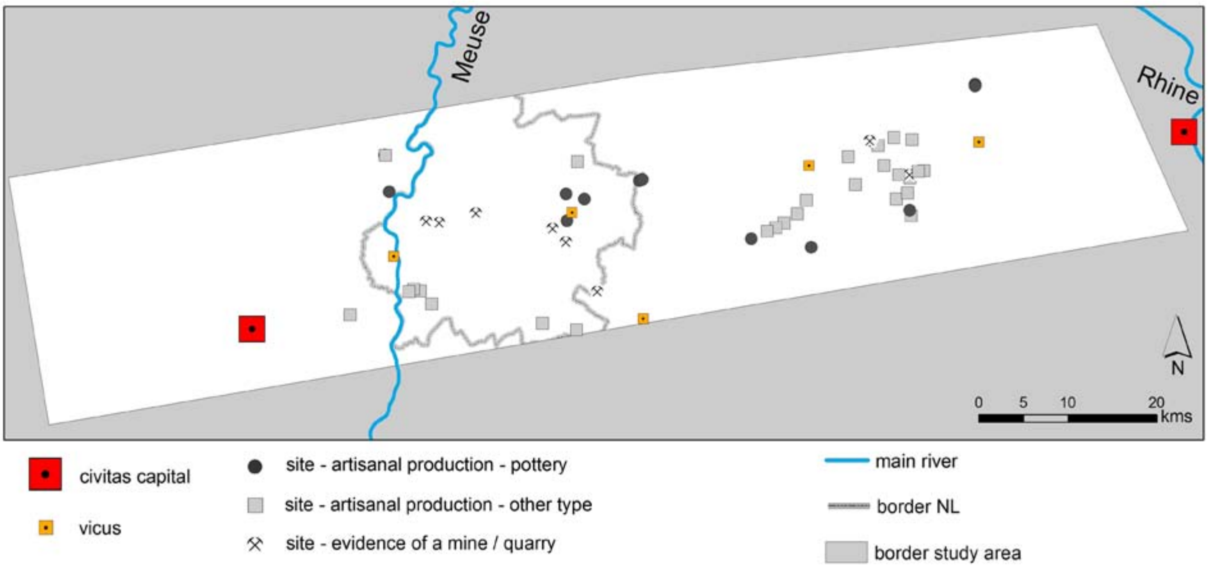


Fig. 4.47. The distribution of the three types of specialist economic activities.

[9] There is a wealth of literature on this subject; for one of the most recent articles, see Roymans / Derks 2011, especially figure 4 on page 17.

In addition to the workshops, eight sites were characterised as quarry / mine sites, most of which were located in modern-day Dutch Limburg. Three of these were discovered by invasive archaeological activities, three by non-invasive methods, with no information regarding the type of research available for the remaining two sites. None of these eight sites could be dated beyond the generic 'Roman period'.

This category has the potential to answer questions regarding the 'landscapes of production'. The results of the analysis regarding type, dating and location of the sites show that, even though there are some significant outcomes, overall, it cannot be concluded that the agrarian production was at any point in time challenged by other types of specialist production. The distribution map, figure 4.47, of the three specialist activities shows that it is possible to indicate some regional specialisation. There appears to have been pottery production centred around *Coriovallum*, metal and glass production around *Juliacum*, and quarrying in the region between modern-day Maastricht and Heerlen. Nevertheless, it is obvious that very little evidence is available regarding the artisanal activities in the region, especially regarding the scale of operations and dating of the sites. It can be concluded that, based on this dataset, it is difficult to generate new information pertinent to the 'patterns of non-agricultural production'- line of inquiry.

4.3.5 CATEGORY 5: TYPES OF SPECIFIC ROMAN FEATURES

At level three the sites in category 5 represent structures with a strict definition regarding both form and function, such as sanctuaries, military sites and rural buildings such as *horrea*.

In the entire study area 24 sanctuaries were found, translating to one per every 144 km^2. 19 (79%) of these sanctuaries were obtained by means of invasive methods, 3 by non-invasive methods, and for 2 sites the method of identification was unknown. Detailed dating information was only available of 4 of these sanctuaries: one to the early Roman period, one to the early to middle period, one to the middle Roman period and one to the early to late period. As shown in figure 4.48, many of these were located in the modern-day region of Dutch South Limburg. When the actual proportion of territory is taken into account, what seems like a disproportionate number of sanctuaries (42%) were located in this region, which only forms 17% of the overall study area. This could be caused by the fact that invasive methods have been used more often here, but it is equally possible that more sanctuaries were located here originally.

Category 5 contains three types of sites with a military nature, army camps, *statios*, and watch towers. Unfortunately, the information regarding this type of site is often highly questionable. To add to the problem, the issue of interpretation and definition of what constitutes a military site has changed considerably over the last decades. Early researchers were often keen to find a Roman military camp or watch tower. The question of what constitutes a military watch tower and how it differs from a civilian *burgus* tower is a good example of this problem.[10] These problems notwithstanding, it can be concluded that the study area was predominantly civilian in nature. Some regulation of the region by the military can be attested, in the form of *statios* for example, but, overall, the number of military installations was very low, compared to the size of the region, translating into 1 military site per 688 kms^2.

[10] In the German part of the study area, square stone foundations of a tower, surrounded by ditches, are interpreted as civilian *burgi*. Examining the archaeological evidence at sites seen as watch towers, for example at the Goudsberg in Dutch Limburg, shows that the find material is often identical to that of the excavated *burgi* in the Hambach area. Compare for example the evidence presented in Bazelmans / Bakels / Kocken 2004 with the plans of excavated *burgi* in the lignite mining zones in the German Rhineland. New research would be welcome in order to establish the true nature of these sites.

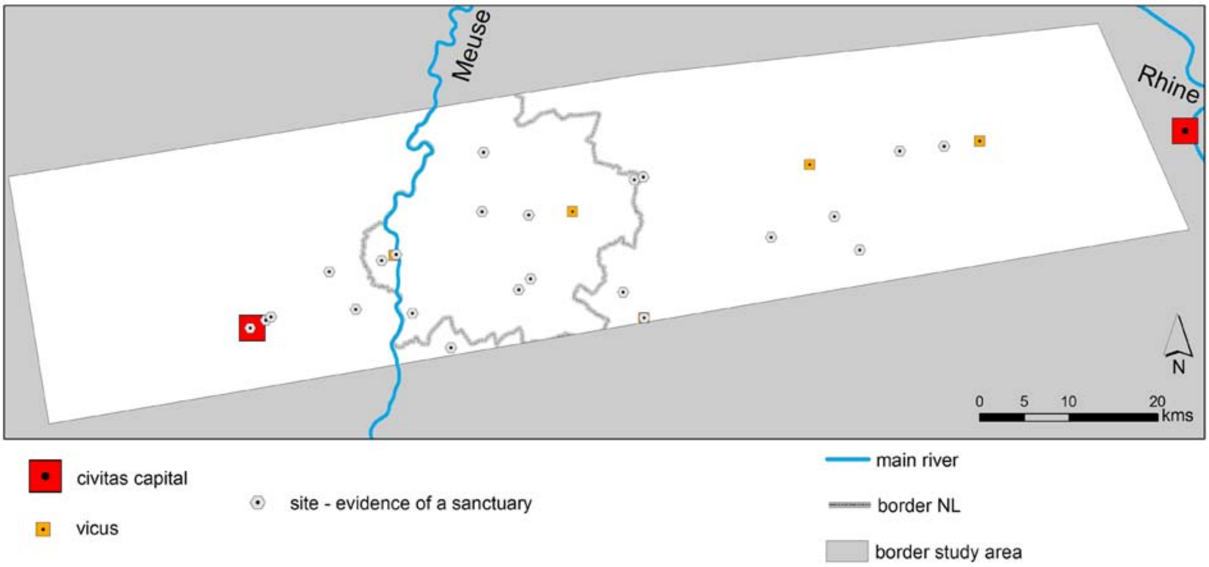


Fig. 4.48. The distribution of 24 sanctuaries in the study area.

A total number of 11 sites were characterised as *burgi*, 9 of which were excavated. 8 sites were dated to the late Roman period, one to the middle to late period, with the date of 2 sites being unknown. The distribution map, figure 4.48, shows that 9 sites were located on German territory, two in Dutch Limburg, with none in the Belgian part of the study area. Only future work will show whether this is an actual pattern from the Roman period, or merely a bias in the data currently available.

The 11 *burgi* are evidence of a dynamic settlement landscape, responding in this case to changes in the provincial-Roman world; namely the worsening safety situation in the late Roman period, because of border control issues in this part of the Empire. It is perhaps no coincidence then that most *burgi* are found closest to the *limes*, whereas the large distance from the land west of the Meuse (and the added protection of the Meuse itself) might account for the lack of *burgi* in that part of the study area.

Of the two types of specific features associated with agricultural activities, 18 *horrea* and 15 land division/ditch systems were mapped in the study region. Once again the much higher numbers of specific features in the German part of the study area stand out, in comparison to the lower number found in the Dutch and Belgian parts, although quite a few ditch systems were found west of the Meuse.

All of the *horrea* identified have resulted from excavations, and 50% of them have been dated to a specific period; 2 to the early to middle Roman period, 5 to the middle Roman period and 2 to the early to late period. With the exception of 1, the ditch systems are not specifically dated. Perhaps surprisingly, 4 of the 15 were obtained through non-invasive research. It can be concluded that the total number of horrea must have been much higher. The traditional practice of only examining the main building of rural settlements has meant that for the majority of rural settlements the auxiliary buildings, including the *horrea*, were overlooked. Recent work on the development trajectories of Roman villas and their granaries in the region has shown the potential of qualitative research on this topic; it is hoped that new data will become available regarding this type of feature in order to elaborate on the subject.[11]

Land division / ditch systems were registered to examine if there was sufficient archaeological evidence in the region for a centuriated landscape. Also, it was examined whether the evidence complied with the assumption of a rectangular grid. The evidence of the German Rhineland showed that,

11 Habermehl 2011, 150-158.

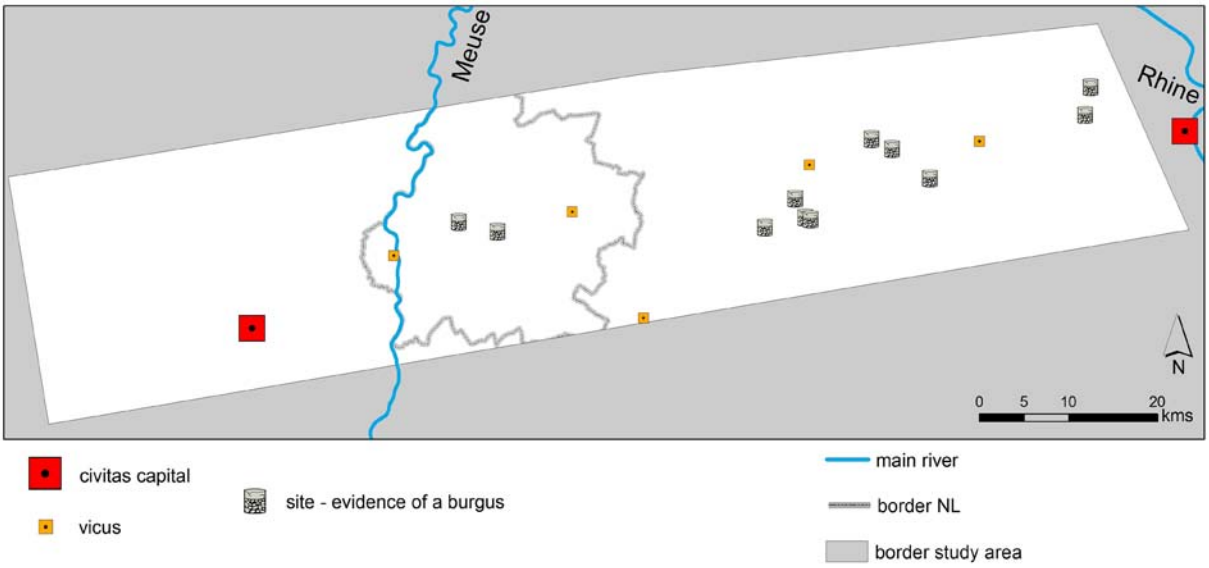


Fig. 4.49. The distribution of 11 *burgi* in the study area.

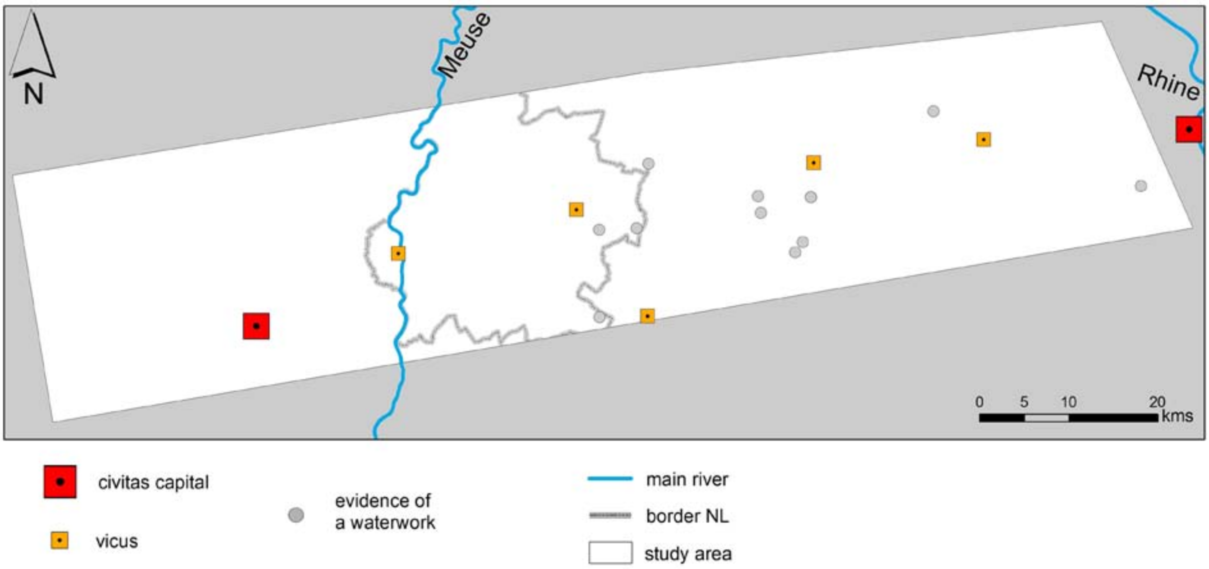


Fig. 4.50. The distribution of 15 waterworks (aqueducts and bath houses) in the study area.

although the ditches around farmyards did show a general orientation to the southeast, there was significant variety in the actual orientation. Due to the underwhelming amount of reliable evidence (15 sites), together with the observation that the ditches found did not point towards a clear rectangular grid, it has to be concluded that the dataset at this point in time is inadequate to offer a reliable verdict on the topic. For this issue to be resolved in the future, a substantial amount of reliable data would be needed, preferably in the form of excavated off-site features.

Waterworks such as bath houses and aqueducts are the final specific type of feature identified in this category at level 3 of interpretation. In total 15 sites were characterised as such. Six were the result of an excavation, 3 of a non-invasive method, and for the remaining 6 the method of identification was unknown. One site was dated to the early to middle Roman period, one to the early to late Roman period, and the other 12 could not be specifically dated. Again, the distribution maps (figs. 4.48-4.50) show that most of these features were found in the central-eastern part of the study region, with few of these items located west of the Meuse.

4.3.6 Category 6: subtypes of indefinable evidence

The final type of evidence explored at level 3 is that of 'indefinable' sites. This category contains evidence that did not allow any characterisation according to the criteria set up for the typology in this study. Nonetheless, it is possible to further characterise the evidence in this category, when focus is placed on the composition of the finds assemblage, resulting in three different types of items in this dataset category: single finds of metal objects such as coins or fibulae, single finds from material other than metal, and small finds assemblages consisting of two or more types of materials, that did not comply with the demands for the 5 other categories.

Starting with the evidence for individual coin and metal finds, 85 items could be characterised as such. The majority were located in the central-western part of the study region, with virtually no sites recorded on land covered by modern day Germany. A major difference between Germany, Belgium and the Netherlands, is that, in Germany, metal detecting is prohibited by law. It is likely that, because of this, people in Germany are discouraged from reporting on finds of coins or other metal finds, resulting in the pattern shown below. Not surprisingly, the majority of this type of site was obtained by means of metal detecting or other non-invasive methods, such as field survey (71%). 23% of this type was obtained by means of invasive research, whereas the identification method was unknown for 6%. Because of the nature of coins and many metal finds, the majority of these sites provided detailed dating information. With 28% dated only as 'Roman', it was found that 33% were dated to the early Roman period, 25% to the early to middle period, 24% to the middle Roman period, and 13% to the late Roman period. The high number of sites dated to the earlier periods is interesting, particularly as this is a deviation from the more general pattern seen earlier in which the middle Roman period seems to be the most well-represented era.

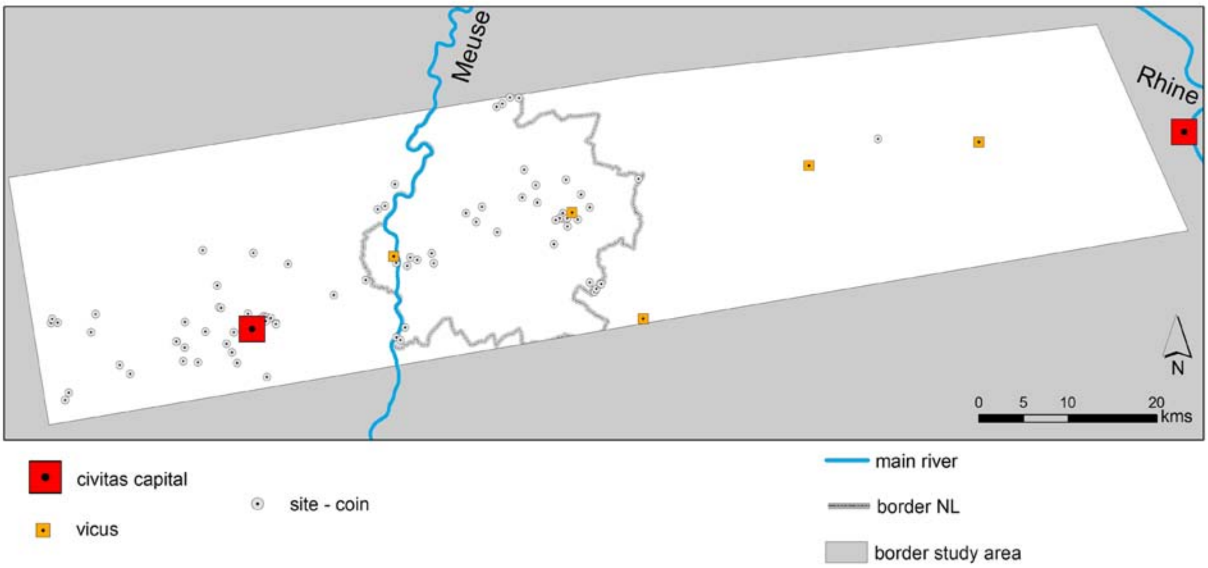


Fig. 4.51. The distribution of individual coin and metal finds.

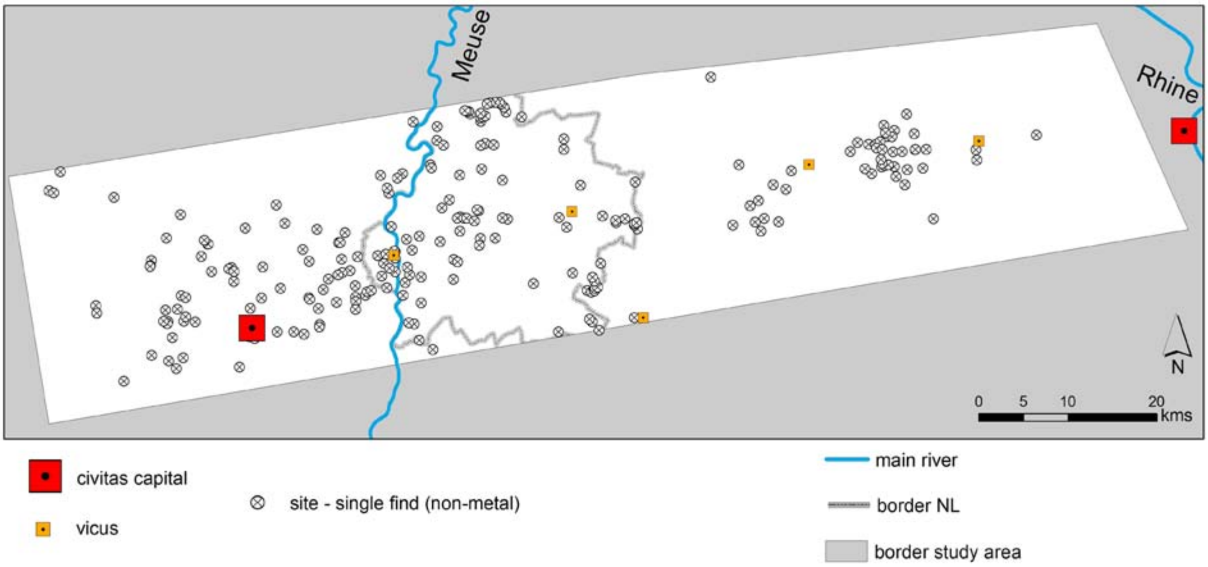


Fig. 4.52. The distribution of single finds.

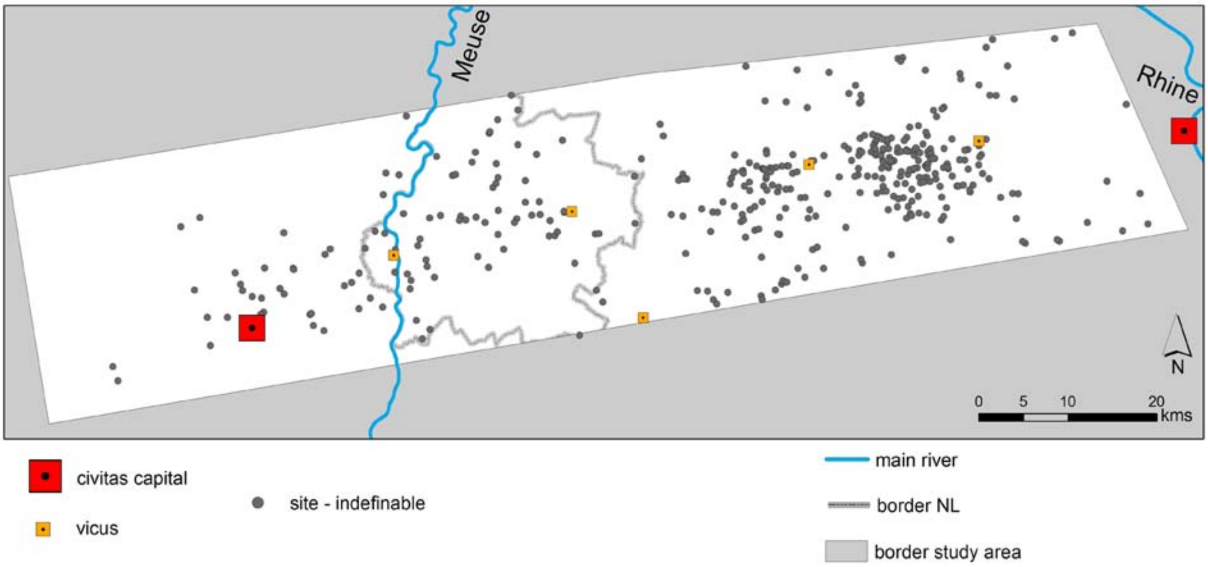


Fig. 4.53. The distribution of undefinable small find assemblages.

In addition to the 85 points representing individual coin or metal finds, 234 were characterised as 'single find – other than metal'. In most cases these consisted of Roman pottery, apparently found on its own. This type of find spot also seems to be predominantly located on Belgian and Dutch territory, rather than in the German part of the study area. Apart from the 12% of items for which the type of archaeological method remains unknown, it is not surprising that the majority of these points were identified obtained through non-invasive methods, primarily field surveys (64%). Still, a quarter of such items (24%) were generated by invasive methods. However, 87% of them could not be dated more specifically than 'Roman'; the few more precisely dated points represented the early (6%), middle (5%) and late periods (2%).

Small find assemblages that could not be characterised, constituted more than half (55%) of category 6. The 395 sites were well spread among the three countries comprising the study region, although there were substantially more in the German region, compared to the other two types of sites in this category. In many cases the find material consisted of fragments of pottery and ceramic building materials, although combinations of any of the miscellaneous find material types were found. Only 10% of such find spots could be dated more precisely than 'Roman-undefined' and, as would be expected, the majority (69%) was obtained by means of non-invasive research, field survey in particular.

The fact that of the entire dataset, almost one quarter of items could not be characterised using the criteria set up specifically for the region, means that a considerable proportion of the archaeological evidence could not be put to use. It is interesting that, for most of the items in this category, the type of archaeological method was known, and that it was often the result of a viable method. Perhaps surprisingly, the largest part of this category consists of two or more types of find material, rather than a single object, coin or otherwise. In the next chapter it will be explored if and how the sites in category 6 can be used in the reconstruction of the settlement landscapes of the region. It is thought that these sites, insignificant though the archaeological material might appear, could represent a particular type of Roman site that, until now, seems to have been overlooked.

4.4 CONCLUSIONS

At the end of the data inventory process it can be concluded that, after 150 years of archaeological activity in the region, there are still many issues that require new empirical data in order to answer even the most basic of questions.

The lack of dated sites stands out in particular. With less than a quarter of the dataset providing details on dating, it is nearly impossible to reconstruct a reliable chronology of the region. The transition from the late La Tène period into the early Roman period especially requires additional data, as does the late Roman period and its development into the early Middle Ages. This study aimed to reconstruct settlement patterns of continuity and change, however, the lack of dated sites seriously limits any attempts at a reliable chronology of the region.

Another result produced by this inventory is the lack of sites with a specific interpretation in the region, especially in the Dutch and Belgian parts of the study area. The fact that of the 3047 sites less than 100 sites have been identified as specific features, such as a *burgus* or a sanctuary, in comparison to the large number of sites interpreted as 'settlement' (and often as 'villa'), can be seen as evidence for the bias in research towards the latter, and the need for new excavations.

With regards to the settlement evidence, the observed dominance of the 1247 sites classified as stone-built, compared to 41 post-built sites, indicates the need for further analysis of this group of sites, and this will be done in the next chapter. However, at this point it can be concluded that the countryside was completely dominated by stone-built rural settlements.

The question of which part of the stone-built rural settlement sites should be considered dwellings of the local elite also requires further attention, as shown by the exploration of additional variables of these sites. This is needed before any further reconstruction of the social organisation of the region can be made. The lack of information regarding details of the lay-out and architecture of many of the stone-built sites indicates that the aim of generating new information regarding the status and architecture of rural settlement will be difficult, if not impossible, to fulfil.

The funeral practice evidence showed a significant pattern of regional diversity through differing monumental burial types, which hint at dominant local practices and regional variety within the study area. It could even reflect the organisation of the region in different *civitates*. However, this type of evidence has also failed to provide detailed dating information that could be of use in reconstructing the region's chronology. This is unfortunate and, once again, highlights the need for new research.

The evidence for road networks reflects a bias towards the main roads identified by the early researchers in the region, as well as the lack of off-site investigations. It is astounding to establish that after 150 years of archaeological work there are still many unanswered questions regarding the location of the main road running from west to east, even less information for roads running north-south, and that the secondary road system has hardly been examined at all.

Last, but not least, the large number of sites that could not be classified according to the criteria set up in this study demonstrates the potential for further research into elements of the landscapes in the region. How to tap into this potential will be explored in the next chapter.

5. The settlement landscapes reconstructed

This chapter demonstrates how the dataset presented in chapter 4 can be used to create a (more) reliable reconstruction of the Roman settlement landscape in the study region. In order to do so a reconstruction method was developed based on the extrapolation of information containing the spatial dimensions and the specific layout of settlements obtained from high quality excavations. This method was applied not only to settlement sites, but also to sites with a different character, such as burials.

The need for a reconstruction of the settlement landscape stems from the nature of the dataset, in combination of course with the research questions defined for this study. As pointed out in chapters 3 and 4, today, it is general practice to record in national databases the results of individual archaeological activities. When the information is synthesised however, this does not automatically result in a reconstructed settlement landscape. In many cases several sites turn out to be evidence of one and the same settlement. Identifying which sites to interpret together as one settlement, and which sites represent two or more distinct settlements, therefore becomes a crucial issue, as it influences key issues such as settlement density. When creating the basic dataset, it was anticipated that further analysis would be necessary before it could be reliably established whether, for example, a post-built and a stone-built structure, found at different times, 250m apart each other, should be interpreted as a single settlement or as two.

Another reason for a reconstruction using more than settlement evidence is the large amount of 'indefinable' sites. As pointed out in chapter 4, this category potentially harbours many more settlements, arguably of the least visible, post-built rural settlement, type. Similarly, the many 'isolated' burials and cemeteries found, apparently without any settlement evidence nearby, could also indicate potential settlements.

Last but not least, subjects such as population size, volume of production, relations between countryside and towns, and the workings of the logistic infrastructure are highly dependent on the quality of the settlement dataset, since the last is the basis for the first. For example, settlement density numbers, defined by the number of settlements in a particular area, are commonly used to estimate population numbers and production volumes, through the application of general assumptions concerning population per settlement and yield per plot size. They are also seen as a reflection of the degree of intensity in which people in the past made use of a specific region. This can be interpreted as an indication of how attractive a region was to the inhabitants, the assumption being that people preferred to live in an area where the environment, both physical and cultural, was beneficial to them. From this viewpoint settlement density numbers can be used to reveal aspects of social behaviour. To provide this, a reliable reconstruction of the settlement landscape is indispensable. It also means that the reliability of the dataset should be considered. When, for example, the settlement density of a specific region is seriously flawed due to bias in research, the reliability of any information based on it is questionable.

Settlement density numbers are highly influenced by the way sites are interpreted and used for the reconstruction of the settlement density. As pointed out earlier, it is often difficult to determine whether a site equals a settlement. Because of this, different categories of sites were mapped in the data inventory phase, for example the plan of a stone-built house, that of a post-built structure, and a burial. It was explained previously that it is possible that some of these sites represented a single rural settlement, whereas others were evidence of separate settlements. Even after the re-evaluation of the basic archaeological information, it can still be said that the resultant dataset requires additional modifications in order to come to a reliable reconstruction of the settlement landscape and subsequent settlement density.

Although reconstructing the settlement landscape at best provides an approximation of the real situation in Roman times, it is believed that the uniform application of a particular method across the entire study area provides more reliable results by ensuring homogeneity and circumnavigating possible biases created through differing research traditions. The dataset presented in chapter 4 was created by mapping the archaeological data according to the spatial information provided, whereby a particular methodology was used concerning find material categories and a specific site type hierarchy. The spatial component of this interpretation exercise entailed using the average dimensions of rural settlements in the region. This chapter demonstrates how a reconstruction method was used, based on the extrapolation of details in terms of lay-out and spatial dimensions of rural settlements, derived from high-quality excavations. The advantage of this method is that different categories of data can be used for the reconstruction, instead of having to rely purely on settlement data. The reconstruction process is introduced below, followed by its results. The final part of the chapter presents and evaluates a settlement density map based on the new reconstruction.

5.1 THE RECONSTRUCTION PROCESS

Before embarking on the explanation of the method for the reconstruction of the settlement landscape, it must be reiterated that it does not replicate the first re-interpretation exercise, as explained in chapter 3. The first re-interpretation revolved around the characterization of sites, according to the system set up beforehand. The system was based on the identification of specific find material categories, that were then used to define certain site types, in particular rural settlements (see 3.4.1). In that phase, the issue of using location and dimensions of different find spots and the distance between them was addressed, and it was argued that separate finds located within 250m of each other should be interpreted as belonging to the same settlement, based on the results of completely excavated farmyards at rural settlements. During that exercise, however, specific types of material evidence, considered as different categories in this study, were mapped separately. Therefore, find spots with evidence of funerary practices, roads, and certain specific types of evidence, such as sanctuaries, were all mapped separately; likewise settlement sites of different nature (stone-built versus post-built) were also registered as individual items in that phase.

The method that will be introduced now, however, concerns the deliberate reconstruction of settlements, using not just those items in the dataset characterised as settlement evidence, but also items from the other categories. This means a reappraisal of the basic dataset presented in the previous chapter, based on new guidelines, which were set up with specific assumptions in mind. The point of departure here concerns the archetypical rural settlement of the period in the study area. Throughout the region completely excavated rural settlements appear to have had a distinct layout, regardless of whether they are characterised as being stone-built or post-built. All demonstrated a recognisable division, typically in the form of a system of ditches, between the inhabited space of the settlement (the farmstead) and its adjacent territory, which was without buildings. A third area, designated for a cemetery, can in many cases also be identified. Figure 5.1, shows an example from the Hambach region, whereby the farmstead (in grey) is seen as a nucleus within the territory (outside of the ditches); the cemetery with several individual burials on the edges of the inhabited space formed a separate zone between the two. On the right this information is translated into an abstract visualisation.

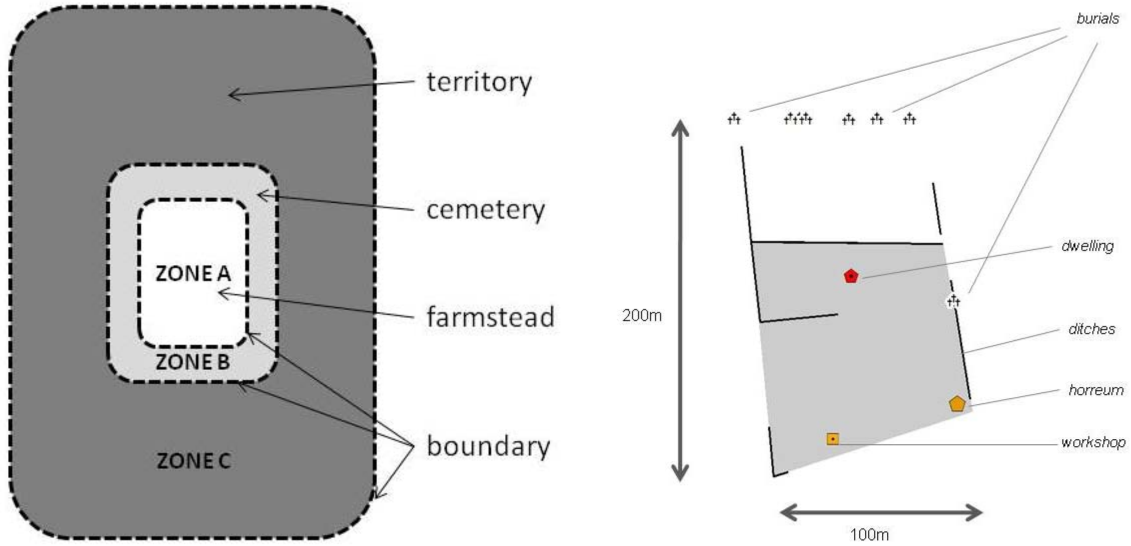


Fig. 5.1 An abstract visualisation of the inhabited part of a Roman rural settlement used in this study, and an example of an actual farmyard excavated in the Hambach area (HA59).

It is argued here that all Roman rural settlements in the study area had a zonal structure as depicted in figure 5.1. The farmstead, zone A, was characterised by the presence of dwellings and utility buildings. Because off-site archaeology has only recently been introduced, for most settlement sites only zone A is known. In fact in most cases only part of zone A is known, as researchers typically examined only the main dwelling. It should be reiterated that the division of a settlement in inhabited and uninhabited parts, marked by a demarcation of the inhabited nucleus, was not restricted to stone-built settlements, as evidenced by completely excavated post-built settlements found in the Belgian and Dutch parts of the study area. These settlements consisted of several contemporary farmhouses made of organic materials, located within rectangular ditch systems and surrounded by arable fields and pastures.[1] In fact this type of settlement can also be found in neighboring regions, for example the Rhine Delta.[2]

The third element in the archetypical settlement concerns the funerary evidence. Burials in a rural context were often located just outside of the ditches or palisades, marking the boundary between farmstead and land, the inhabited and the uninhabited space. This identifies a third element in the settlement, the cemetery, as shown in figure 5.1.

The functionality of the aspects mentioned above lie in the fact that it is possible to determine spatial dimensions for zone A, the farmstead or inhabited space. Through the use of a GIS and the results of excavations that examined the entire farmstead, individual cases could each be measured, and thus a range and average value for this zone established. As pointed out in chapter 3, enclosed farmyards in the region measured on average approximately 2.5 hectare, with the largest farmyard measuring nearly 7 hectares (WW 122) and the smallest less than 1 hectare (HA 69, Nuth-Vaesrade). This information had to be converted into dimensions of length and width, because the maximum length/width was important for determining the maximum radius applied to zone A. Detailed examination of the excavated farmyards in the study area showed that they were all rectangular structures with fixed length-width dimensions. This means that, although an area of 2 hectares could in theory be anything from a square of 141m x 141m to a rectangular of 10m by 2000m, in practice, the length-width ratio

1 Vanderhoeven 2006, Tichelman in prep.

2 See for example Vos 2009, chapters 3 and 4.

is such that odd-shaped rectangles are rarely found, if at all. There have been 18 completely excavated farmyards in the study area, and these have the following length-width dimensions:

site	width (m)	length (m)	area (m2)	remark
WW 81	85	85	7,284	
HA 69	89	107	9,925	
Nuth Vaesrade	100	100	9,999	L/W dimensions by approximation
Spaubeek zuid	78	133	10,481	
HA 130	85	115	10,565	
HA 516	86	135	11,351	
HA 59	104	109	11,801	
HA 53	98	176	17,507	
K-HOLZ	90	219	20,154	
HA 512	119	213	25,013	
HA 412	139	158	25,143	
HA 303A	110	140	30,464	Settlement HA303 consists of two individual adjoining and enclosed settlements
HA 303B	70	223		
Butterweiden	140	250	34,873	L/W by approximation
Backerbosch	200	200	38,818	L/W dimensions by approximation
HA 132	200	250	48,933	
WW 122	265	265	69,866	L/W by approximation
Herkenberg	217	244	53,787	L/W dimensions by approximation

Tab. 5.1 Spatial dimensions of completely excavated farmsteads (zone A).

Table 5.1 shows that all of the 18 farmyards were rectangular, with the proportion of width to length ranging from 1:1 (HA 59) to 3:7 (Kerkrade – Holzkuil), but the most common proportion seems to be 2:3 (HA 130, HA 516, HA 53, HA 512, HA 132, Butterweiden, Spaubeek Zuid). Using the average value of 2.5 hectares and a proportion of 2:3 this corresponds to a rectangular structure of 125m x 200m; using the 3:7 proportion results in dimensions of 100m x 250m. This information was used to add a spatial dimension to the abstract visualisation, as shown in figure 5.2. The measurements of the 'average built area' could now be applied to the basic dataset map; archaeological evidence found within the indicated dimensions was seen as belonging to one single settlement.

The zonal layout of Roman rural settlements combined with the average dimensions of the inhabited zone made it possible to re-interpret different categories of sites when reconstructing individual settlements and entire settlement landscapes. For example, when two sites consisting of settlement evidence were found in close proximity, the actual distance between them determined whether to interpret them together as a single settlement or whether they represented two distinct settlements. A post-built structure could be interpreted as a singular structure on its own, as part of a settlement with other post-built structures, or as part of a settlement that also included a stone-built dwelling; the distance between the sites determined the final interpretation. A burial or cemetery found at a different point in time could be said to belong to a settlement when it fell within the dimensions determined above.

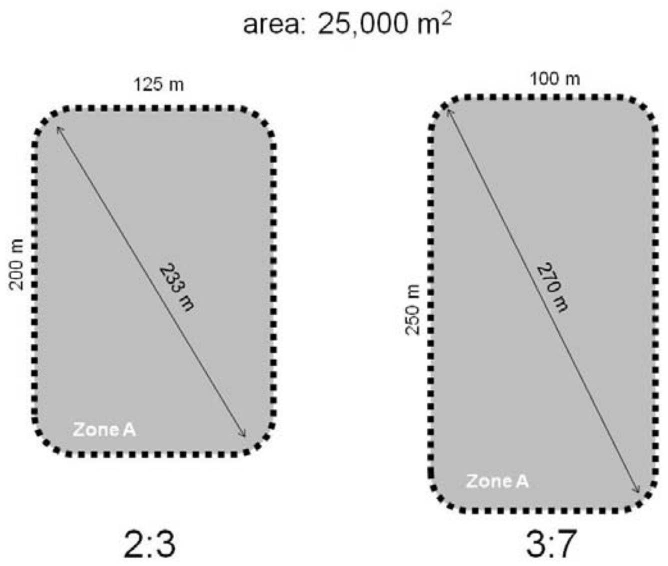
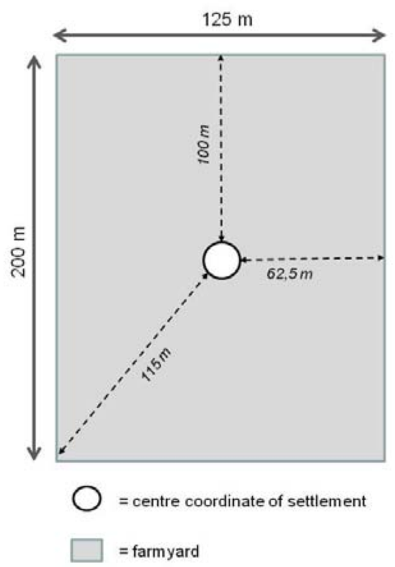


Fig. 5.2 Average spatial dimensions of a farmstead (zone A) of a Roman rural settlement.

When using this method of interpretation, it has to be emphasized that this study uses point locations to indicate sites, but of course these sites represent polygons. Each point location is based on the information provided by the source; if possible, the point location represents the centre coordinate of the actual settlement, but in most cases it refers to the centre coordinate of the researched area, or of the main structure found, and sometimes it is only an approximation of the location of the site. It matters a great deal, however, where the point is placed within the polygon, especially as the re-evaluation is based on distance. Figures 5.3 a and b explain this.

Figure 5.3a shows a situation whereby the centre coordinate provided by the source represents the actual centre of the farmyard. In this case the maximum distance between the point and another structure falling within the farmyard can be 115m, if the average dimension of a rural settlement is used as a yardstick. However, if the point location represents the centre of the main building, it does not coincide with the centre of the farmyard, as shown in figure 5.3a. In the study area the (stone-built) main building is rarely found in the centre of the farmyard, as shown in figure 5.4 for the HA 69 settlement. Figure 5.3b also shows that this has implications for the maximum possible distance between the point location of the settlement site and a secondary structure, which, as is shown on 5.3b, could be as much as 225m.



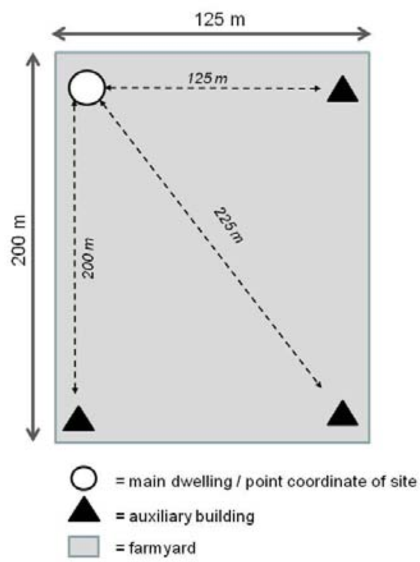


Fig. 5.3a (left) and 5.3b (right) Roman rural settlement representation with distances based on the location of the point coordinate provided for the site.

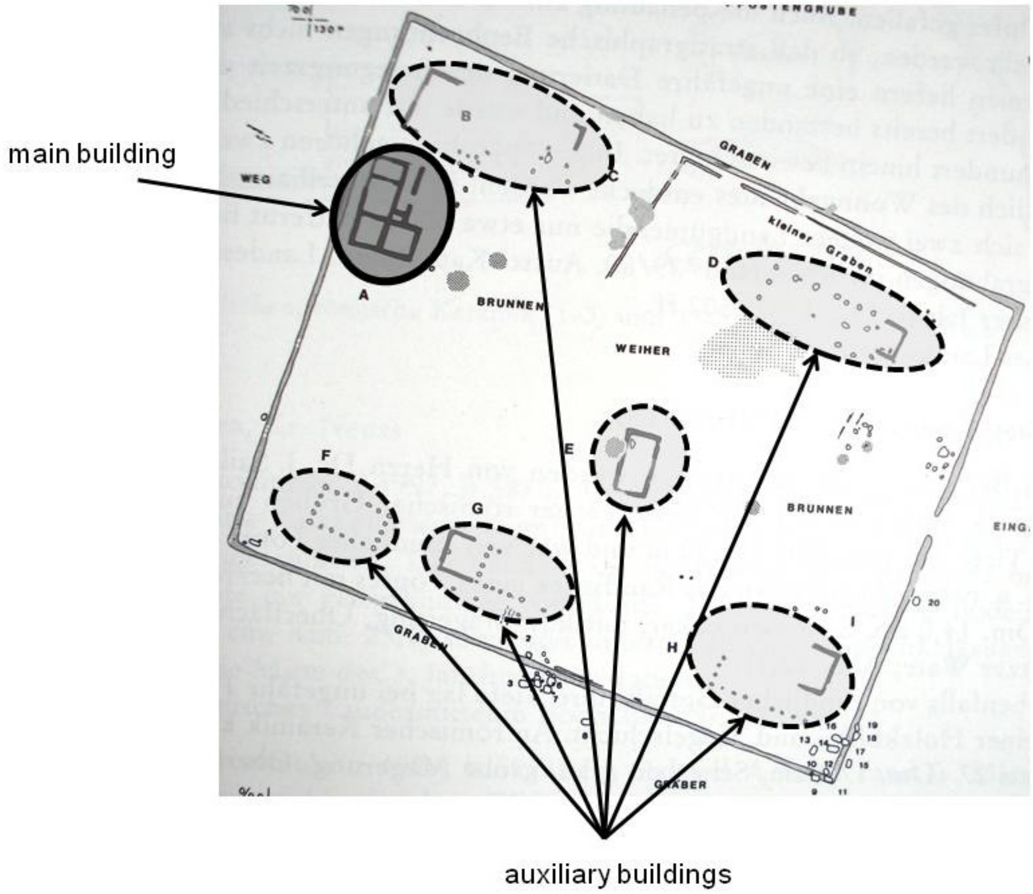


Fig. 5.4 Plan of the Roman stone-built rural site HA 69, showing the location of the main building and that of several auxiliary buildings. The main building was clearly not located at the centre of the farmyard. Source: Ambt für Bodendenkmalpflege Rheinlands, Außenstelle Titz-Höllen; plan by W. Gaitzsch.

5.1.1 APPLYING THE METHOD TO THE SETTLEMENT EVIDENCE

Based on the evidence presented in table 5.1, it was decided to use the 250m-dimension as a yardstick. In a GIS a buffer of the desired dimension can be created around each site, by means of the buffer tool.[3] To evaluate the settlement evidence, a buffer was created of 125m around each site in the settlement data category, based on the 250m average distance. By means of a visual inspection of the resulting map, sites that fell within 250m distance of each other could be easily identified, as the maps showsed which buffers overlapped. The result of this exercise is shown in figure 5.5. In this map it is clearly visible that points no. 237 and 267 lay further than 250m apart from each other, and they are therefore seen as individual settlements. Points 238 and 268, however, lay within 250m distance of each other, as the 125m buffers overlap; following the assumptions described earlier, these points were considered as two structures of the same settlement, and in the new dataset were mapped as a single settlement.

Of course in order to justify merging two sites into one single settlement, the database needed to be consulted, in order to see what exactly was found at each site, and by what means. In the case of points 238 and 268 in the example above, both sites were identified by field walking, and in both

3 Buffer tool in the Proximity toolbox of the ArcToolbox of ArcMap version 9.3.

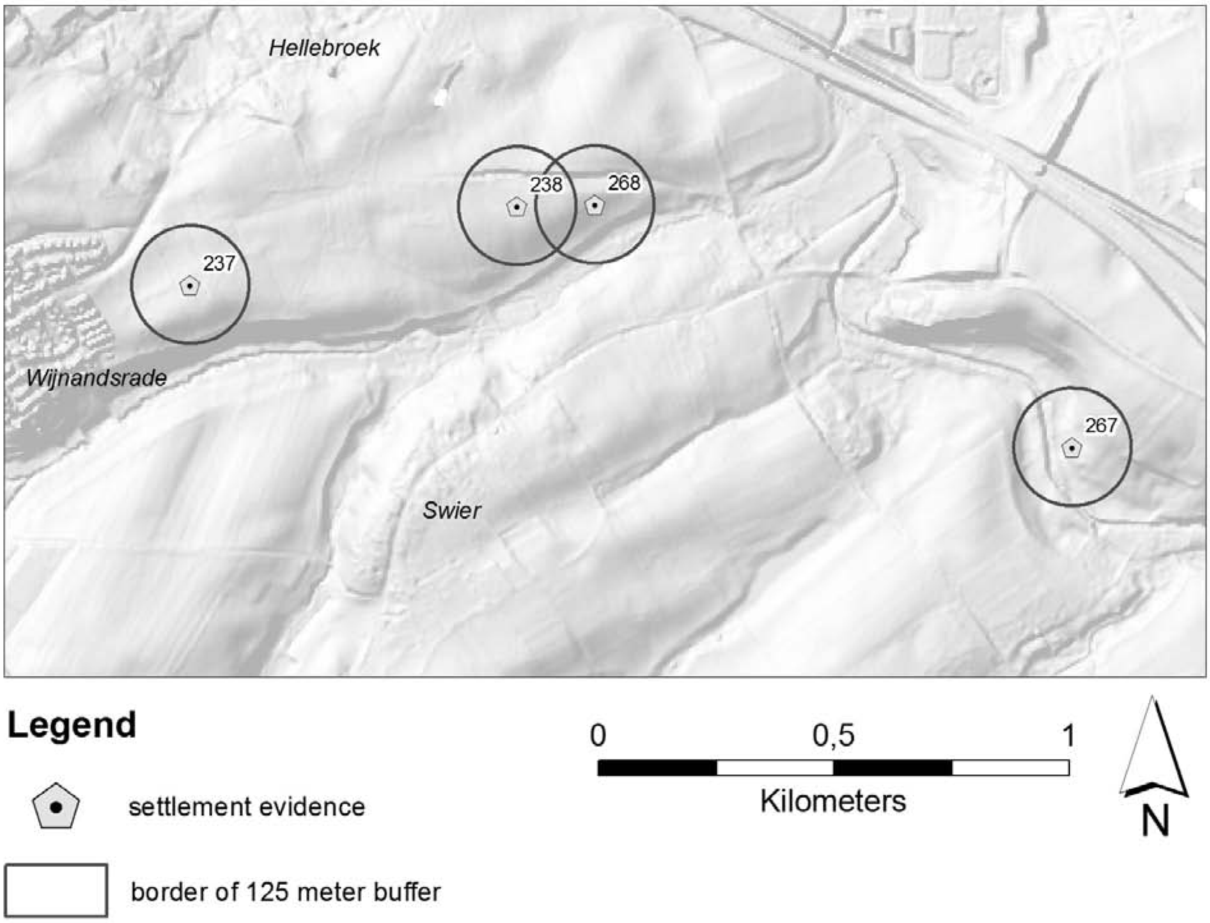


Fig. 5.5 Results of buffering the settlement evidence with 125m-zones, in Dutch Limburg east of Wijnandsrade.

cases the material was evidence of a settlement made with stone and ceramic building material. The database was also checked for the attribute 'reliability of location information'; if one or both sites scored low on this attribute, this needed to be marked in the attribute of the resultant (single) site. Last, but not least, the dating of the evidence was also important: if one site was dated early Roman and the other middle to late Roman, it had to be examined whether they should be considered as two separate settlements (based, for example, on the find material) or as one single settlement with separate phases. A good example of this were the *burgi*, that in almost all cases were located within 250m of a rural settlement that was typically dated to the middle Roman period; the *burgus* constituting a late Roman phase of the settlement. As was indicated earlier, the majority of the dataset lacked information regarding the precise dating of individual sites, therefore it was decided that the reconstruction of the landscape would be that of the middle Roman period. Because of this, the *burgus* evidence as such was not counted as an individual, additional settlement.

5.1.2 APPLYING THE METHOD TO THE FUNERARY EVIDENCE

The spatial relation between rural settlements and funerary evidence, shown in figure 5.1 and in figure 5.6 can be used to identify settlements that are not (yet) discovered, based on the same assumptions regarding layout and size of settlements.

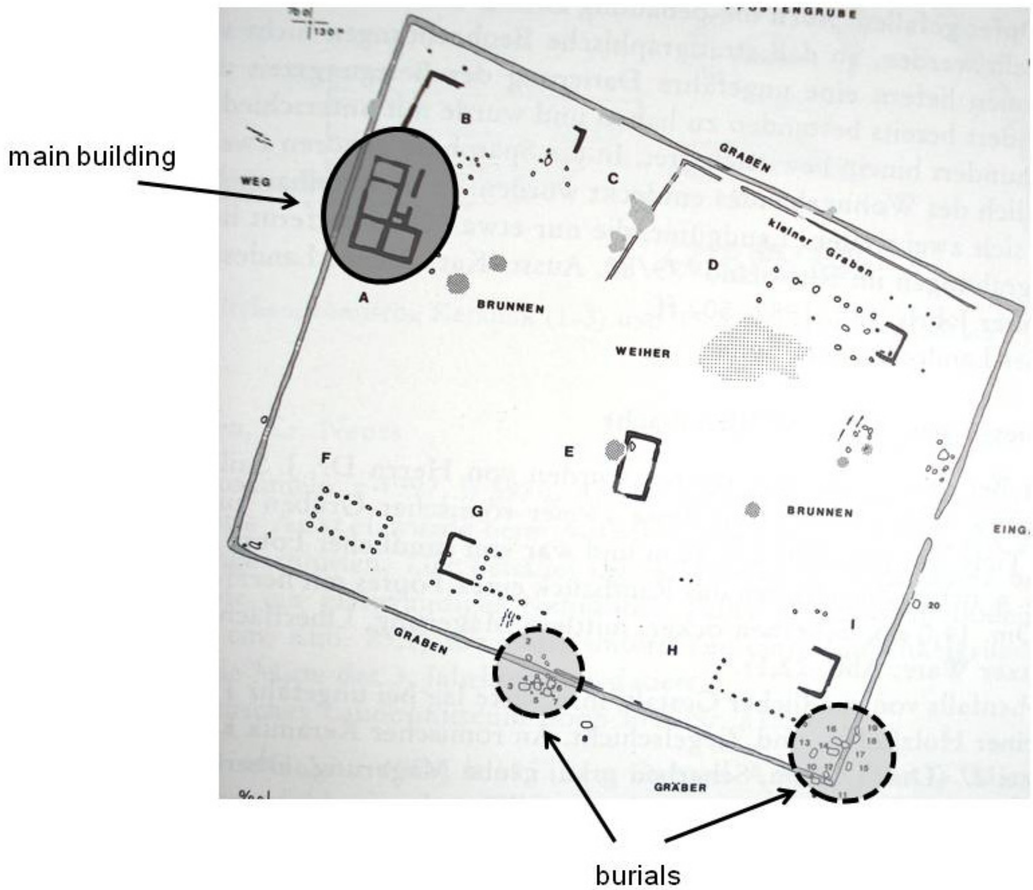


Fig. 5.6 Example of the Roman stone-built rural site HA69 (German Rhineland), with two cemeteries located alongside the main enclosure of the farmstead (zone A). Source: Ambt für Bodendenkmalpflege Rheinlands, Außenstelle Titz-Höllen; plan by W. Gaitzsch.

Using the estimated dimensions of rural farmyards, the average distance between settlement site and its related cemeteries could be established, as shown in figure 5.7. Based on the assumptions regarding the regular layout of Roman farmyards, as shown in figure 5.1, it is argued that funerary evidence located at a distance of 250m or less from a rural settlement was part of that settlement. It could be assumed then that funerary evidence found without any settlement evidence closeby could represent a settlement that has not (yet) been discovered.

It goes without saying that it is important to use the re-evaluated settlement dataset, rather than the basic dataset presented in chapter 3. Using the 'select by location' tool, all points with funerary evidence located outside of 250m-buffers around settlement sites were selected. This subset of funerary evidence could, in principle, represent an additional number of settlements. However, additional analysis was necessary. Figure 5.6 shows that several small cemeteries could be present at just one settlement. Therefore it was important not only to determine the distance between settlement and funerary evidence, but also to measure the distance between individual burial sites. Burials located within 250m of a settlement site and of each other were considered as belonging to one and the same cemetery, belonging to one settlement. Figures 5.7 a and b summarize these assumptions.

An isolated burial could also be evidence of an urban settlement, such as a *vicus* or town. However, generally such burials were much more numerous, and located in close proximity to a main road; the four funerary zones outside of *Coriovallum* being a case in point. Therefore, when funerary evidence

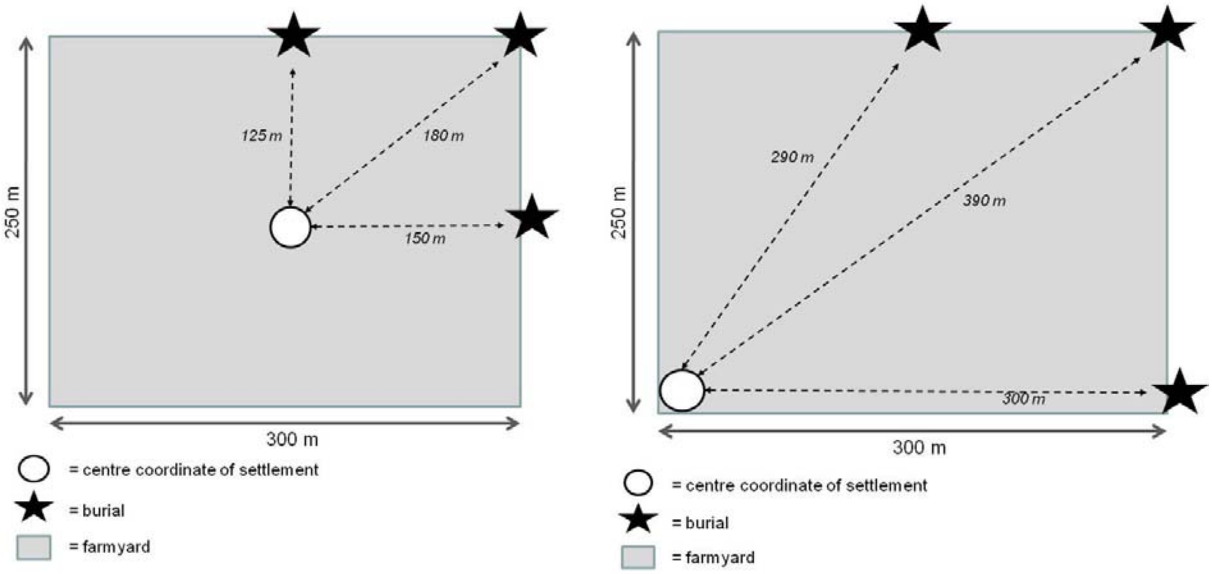


Fig. 5.7a and b. Settlement model with funerary evidence, showing the dimensions used to establish the maximum distance.

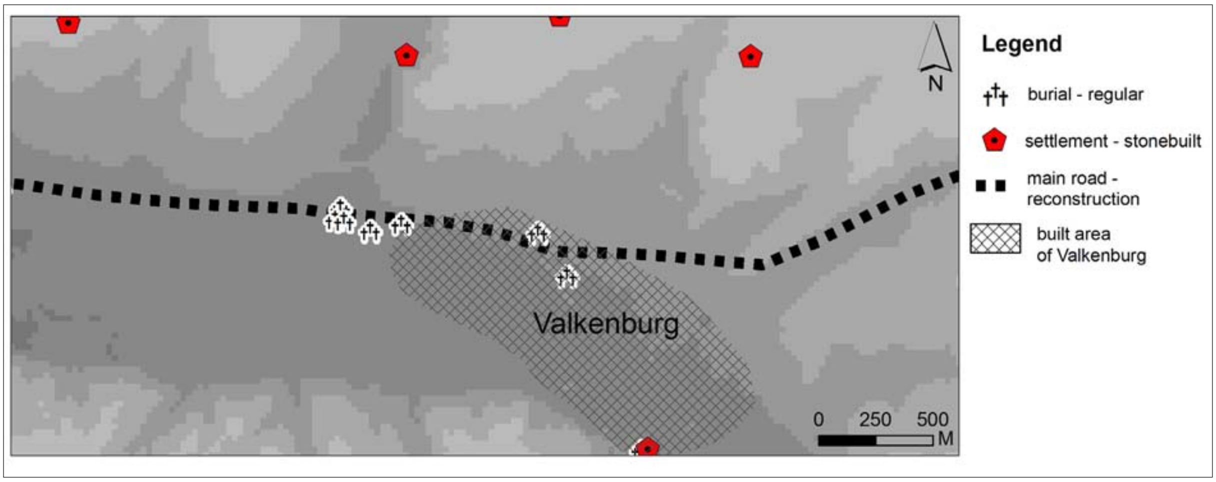


Fig. 5.8 West of the current town of *Valkenburg* (Dutch Limburg) several burials have been identified in close proximity to each other and to the main Roman road. Settlement evidence close to these burials has not been found, but the number of burials, in combination with their proximity to the main road, seems to indicate a so far unknown conglomerated Roman roadside settlement.

was found in close proximity to evidence of a main road, but without any evidence of a nucleated settlement, the association between the three types of sites could be used to identify roadside settlements that have not (yet) been discovered. Figure 5.8 shows an example from Dutch Limburg, west of the modern day town of *Valkenburg*, where this might be the case.

5.1.3 APPLYING THE METHOD TO INDEFINABLE EVIDENCE

The third category that could be used to reconstruct the settlement landscape is that of the indefinable evidence. As pointed out in chapter 3.3, wherever insufficient evidence had been found to classify it as either settlement, burial, infrastructure, specialist craft or special feature, as defined in this study, that point was registered in a separate category. It was either a metal/coin find, a single (non-metal) find, or 'indefinable' evidence when more than one type of material was found. It is argued here that, although in some cases the evidence is questionable and unconvincing proof of a settlement, this category is not without interest for the reconstruction of the settlement landscape.

Typically points characterised as 'indefinable' consisted of find materials from category 9, such as pottery and small metal finds; many were the result of non-invasive activities such as field walking. It is not unthinkable that these finds represent post-built features. It has already been described that archaeological practices in the past focused almost exclusively on stone-built structures. Even today post-built settlements are hard to recognise because of the nature of their material evidence. However, since this study aims to reconstruct the settlement landscape in its totality, it is argued here that the 'indefinable' sub-dataset must be explored for its potential contribution to the category of post-built features. A findspot consisting of a single type of material evidence will always be considered less reliable than that where two or more types of material evidence have been found. Ultimately, however, the most important factor to take into consideration is the actual material itself, necessitating an evaluation of each individual point classified as 'indefinable'.

As with the funerary evidence, it was assumed, based on the dimensions of an average settlement (stone-built or post-built), that any point classified as 'indefinable' located within a 250-m distance of a settlement, should be seen as belonging to that settlement. Roman rural settlements typically consisted of several features, either stone or post-built. In addition, several activities in and around the farmyard would have left behind debris and post-depositional processes, such as ploughing, will have added to the scattering of find materials. Working from these assumptions, points classified as 'indefinable' and located at more than 250 meters from settlements were selected. Next the distance to funeral evidence and to other points of category 6 was examined. This way a new subset of points was made. It is argued that the points in this subset could potentially represent settlements not (yet) discovered, in a manner similar to that of the funerary evidence. The following discusses how these points were characterised.

5.1.4 INTERPRETING THE NEW DATASET

In attempting to reconstruct the settlement landscape of the study area, a major challenge, following the reinterpretation of non-settlement evidence as settlements, was to see whether it was possible to interpret the new sites at level 3. To do this the nature of the archaeological evidence needed to be examined, as the interpretation relied heavily upon certain assumptions concerning the material culture of the settlement types and their inhabitants.

For the two categories that were re-evaluated, the labels used at level 3 were:

Funerary evidence:

- Regular burial
- Monumental burial (*tumulus*/grave marker/large stone incinerary urn)
- Combination of regular + monumental funerary evidence

Non-classified evidence:

- Two or more types of find material
- Single find – non-metal
- Single find - coin / metal

As indicated earlier, stone-built rural settlements were, in general, seen as dwellings of the more affluent part of the population. Following that line of thinking it was to be expected that monumental burials, such as *tumuli* and large stone incinerary urns, were evidence of dwellings of that part of society usually associated with stone-built settlements. Therefore it was decided that monumental burial evidence, or a combination of both monumental and regular burial evidence, should be interpreted as remains of a stone-built settlement. Regular burial evidence, however, could be an indication of any type of settlement and therefore it had to be accepted that in these cases no interpretation at level 3 could be done. Such resulting points were given the label 'settlement – undefined'.

The use of non-classified evidence for interpreting settlement sites at level 3 relies on further assumptions, not only concerning the material culture of specific settlement types, but also the post-depositional processes and the reliability of the archaeological information. These assumptions were as follows:

- the material found on site had to be a fair representation of the original settlement, i.e. there had not been a deliberate removal of a specific type of find material, such as stone used as a building material;
- the information relating to the find material situation was sufficiently reliable, meaning that when certain key types of material were not mentioned by the source, it could be reliably assumed that they were not present on site.

These assumptions depended on the reliability of the information, often related to the reliability of the source. Therefore, the database needed to be consulted for each individual case. When it was established that the site information did not comply with the required quality, it was decided not to include the point in the settlement landscape reconstruction. Sites deemed reliable enough to count as a settlement site were evaluated based on the find material. It was assumed that a site could be reliably said to have been of the post-built type when more than one type of find material was found, for example pottery fragments together with metal finds, without any mention of natural stone used as building material. Information on the quantity of the material found was crucial too: reports of a single or a small scattering of pottery fragments was not considered as sufficient evidence for a settlement. Unfortunately, this information was not available for every item in categories 2 and 6.

Items consisting of single finds and coin/metal finds were also taken into consideration. However in these cases even stricter rules applied. A single coin or a single sherd were not seen as sufficient evidence of a settlement; only sites where several metal finds have been reported, or where metal finds were found within 250 meters of other sites, or significant finds such as coin hoards were assumed to be a reliable indication of a settlement.

In sum, it is argued in the above that burial and non-classified evidence can be used to interpret settlement sites at level 3. However, the process is not without problems, and interpretation can only be done on a site-by-site basis. It must be pointed out that the interpretation at level 3 relies heavily on assumptions, even more so than at level 2. With these caveats in place an examination of the results of the reconstruction process is made.

5.2 REBUILDING THE SETTLEMENT LANDSCAPE

The results of the application of the new method introduced in the previous part is presented below, starting with the reappraisal of the category of settlement sites, followed by that of funerary and non-classified evidence.

5.2.1 REAPPRAISAL OF THE SETTLEMENT EVIDENCE

The settlement evidence category presented in chapter 4 contained 1301 items. As was to be expected, the application of the new method to the settlement evidence resulted in a reduction of the number of sites, because 115 sites were located within the defined 250-meter area discounting them from classification as individual settlements. The reappraised settlement dataset contains 1186 settlements.

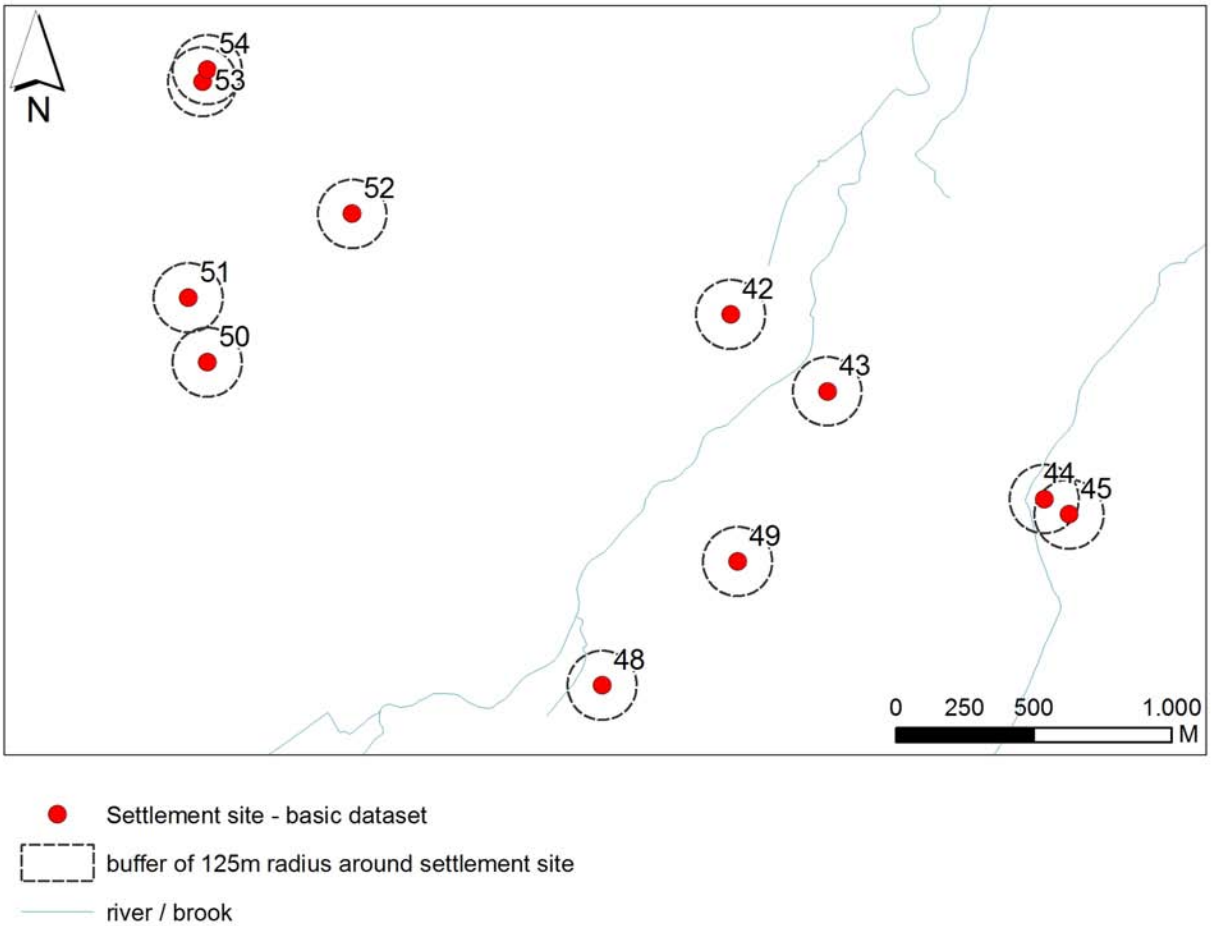


Fig. 5.9a Example of the results of the analysis of the settlement evidence using the method introduced in this chapter, for a number of sites in the Belgian part of the study area. The buffers of 125 m radius overlap in three cases, indicating that these sites should be merged.

Figures 5.9a and b show an example of the reappraisal process in the Belgian part of the study area, where eleven settlement sites were re-evaluated using the settlement model. The use of the 250-meter buffers shows that, of these eleven sites, six were located within 250 meters of each other, resulting in a reduction in the number of settlements in the area from eleven to eight.

Of the 1186 settlements, the *civitas* capitals and *vici* already known, remained. However, the number of *vici* was reduced from 11 to 10, as two sites registered individually were re-evaluated as a single urban settlement.[4]

Regarding the rural settlements, the original dataset contained 1247 sites characterised as 'stone-built'. After the reappraisal 1145 settlements were interpreted as such. This means a reduction of 102 sites. Of the 41 sites characterised as post-built, only 27 settlements remained. The ratio of stone-built to post-built settlements became 98% - 2%; in the original dataset this was 97%-3%. The lower number of post-built settlements was because several of the sites identified as 'post-built' either formed part of a stone-built settlement, or turned out to be the (early Roman) predecessor of a settlement that, in a later phase, turns into a stone-built settlement. The distribution map of the 26 post-built sites, shows

[4] This concerns the two sites located on both sides of the Worm river on the Dutch-German border. These two sites obviously formed one roadside village, situated on both sides of the bridge across the Worm.

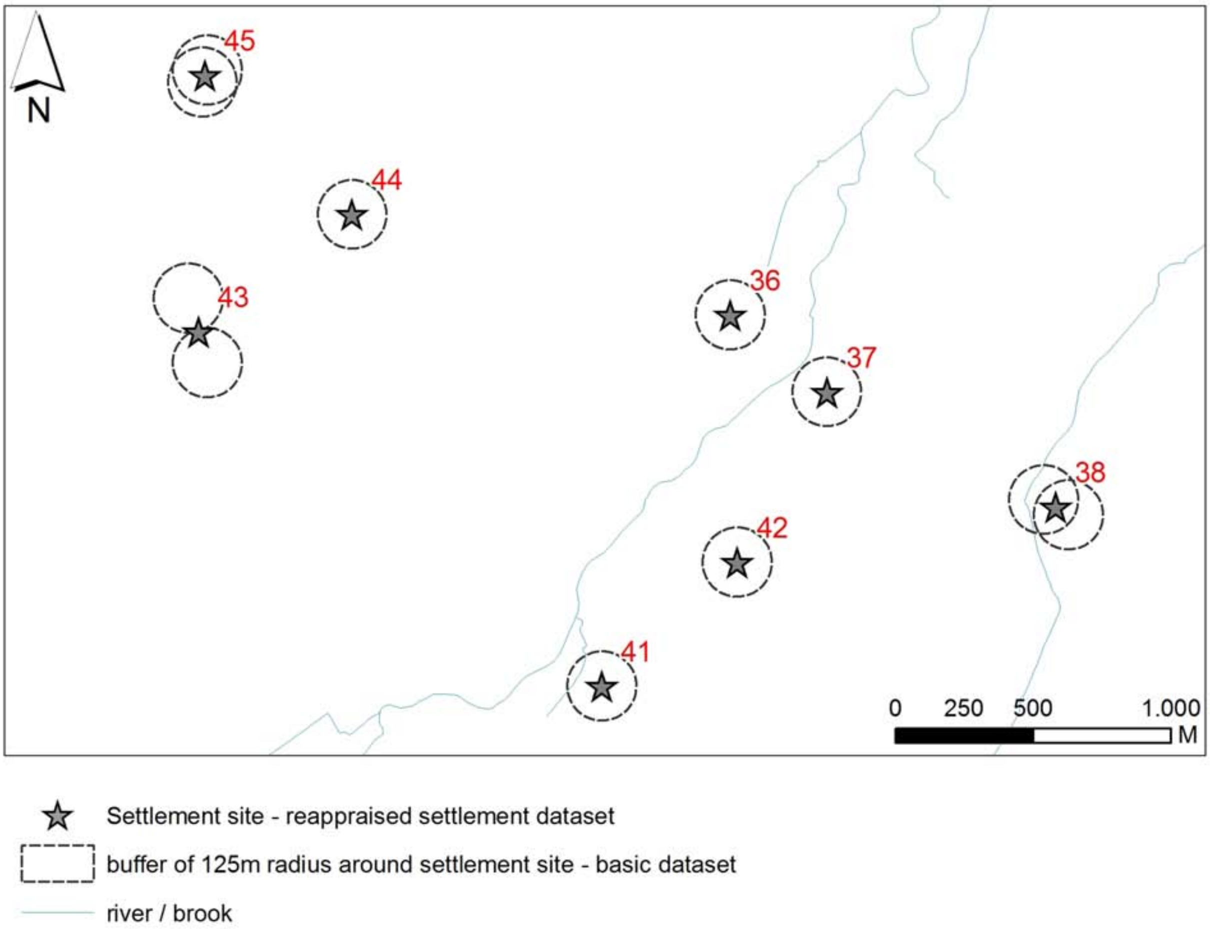


Fig. 5.9b The results of the reappraisal process. Sites 53 and 54 (see figure 5.9A) were merged to form one settlement site (number 45), sites 50 and 51 formed the site number 43, and sites 44 and 45 formed the settlement site number 38.

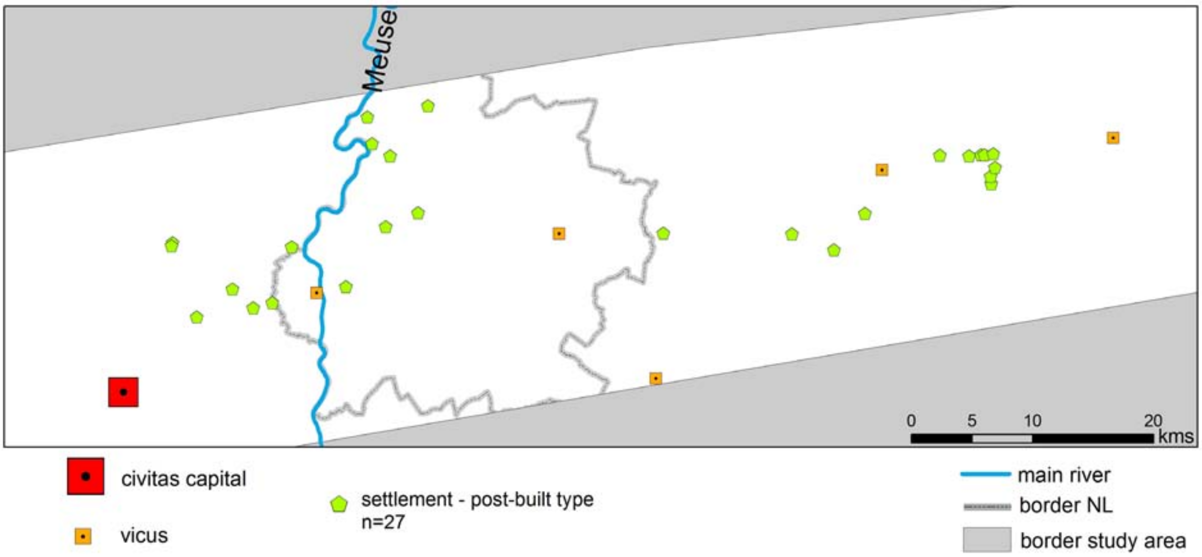


Fig. 5.10 Distribution of the 27 settlements characterised as 'post-built' in the reappraised settlement dataset.

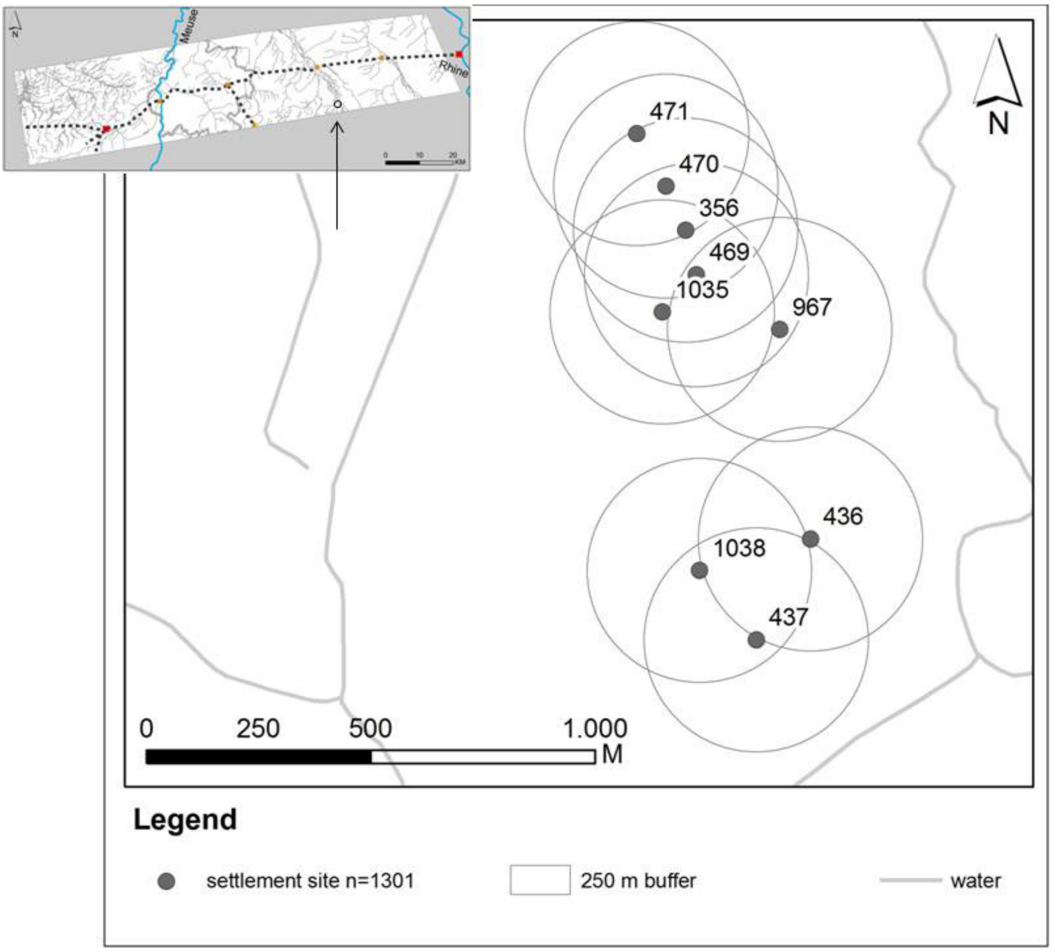


Fig. 5.11. Example of the results of the buffering exercise in the centre-south part of the German part of the study area. Sites 436, 437 and 1038 were interpreted together as one rural settlement – stonebuilt. Sites 356, 469, 470, 471, 967 and 1035, however, were interpreted together as a large cluster of habitation evidence.

that there are two clusters of such sites: on both sides of the Meuse and around the Roman town of *Juliacum*. 13 of these sites were dated to the early Roman period, 3 to the early to middle Roman period, 3 to the middle Roman period, with no dating information available for the remaining 7 settlements.

The application of the method has also had an unexpected result, leading to the discovery of what seem to be new clusters of habitation. As shown in figure 5.11, the buffer exercise has revealed instances where more than two buffers overlap. This resulted in a settlement area with unusual dimensions, with a length of nearly 1 kilometre in the case of figure 5.11. Whether this constituted one large linear settlement, which should be interpreted as a village, or whether the evidence must be interpreted otherwise, remains a subject for future investigations, preferably in the form of further (invasive) archaeological activities. Three of such settlement clusters have been discovered this way.

5.2.2 Reappraisal of the funerary evidence

Starting with the reappraised settlement dataset of 1186 sites, the method was next applied to the dataset of funerary evidence. Category 2 contained 646 items, of which 291 were found to be located within 250 meters of a settlement. This meant that the other 355 presumably represented settlements.

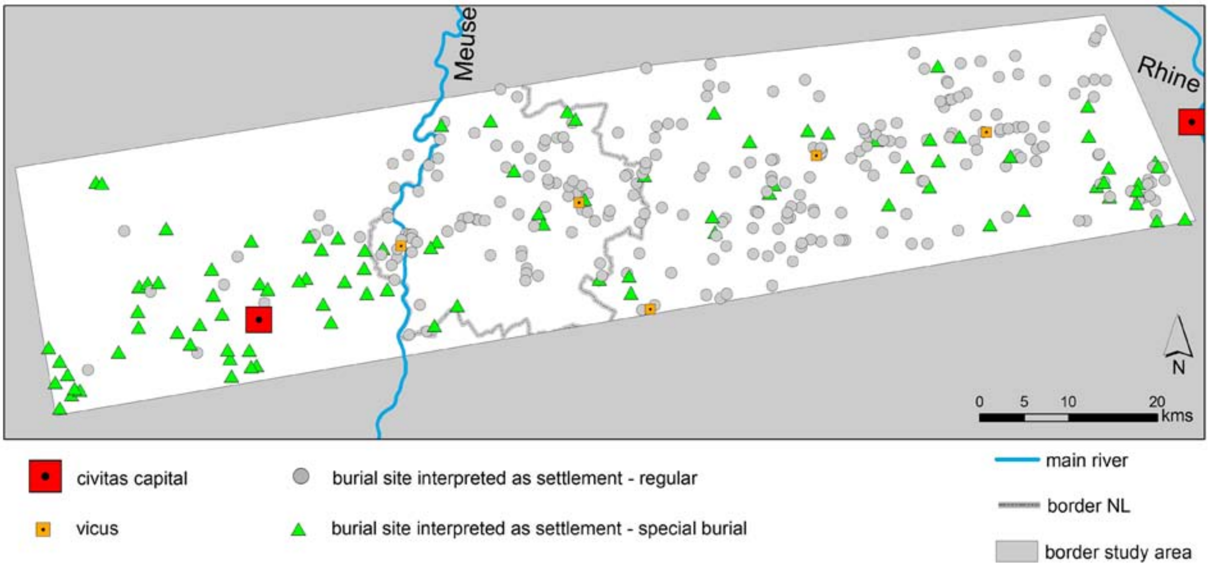


Fig. 5.12. Distribution map of the 355 points from the burial dataset interpreted as settlements.

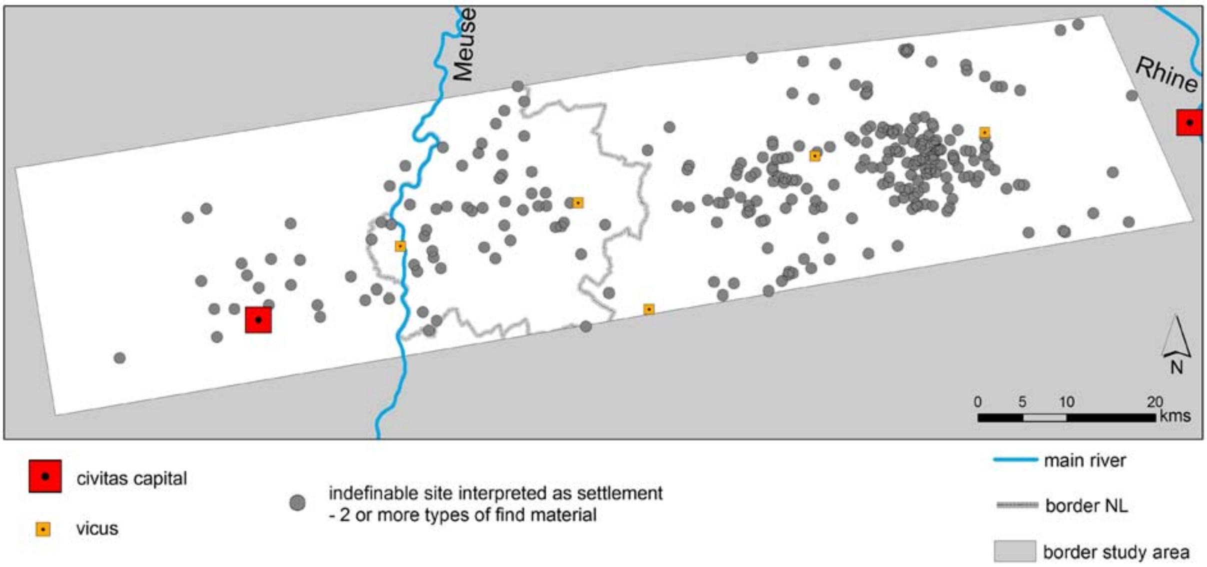


Fig. 5.13. Distribution of the 264 points from category 6 where two or more types of find material were recorded, that were reappraised as possible settlement evidence.

262 of these were regular burials, and 93 were of a monumental nature: 7 monumental grave markers, 27 large stone incinerary urns, and 48 *tumuli*. In 11 cases regular and monumental funerary evidence could be interpreted together as they were located less than 250 meter distance to each other. Following the assumption that the 355 points with burial evidence represented settlements, the total number of settlements increased from 1186 to 1541.

262 points consisted of regular funerary evidence. This meant that it was not possible to predict the type of the assumed related settlement. The monumental funerary evidence, however, suggested that 93 of the additional settlements were of the stone-built type. This would increase the number of stone-built rural settlements from 1145 to 1238.

The distribution map of the 355 additional settlements shows that they were fairly evenly spaced out across the entire study area. However, the high number of monumental burials interpreted as set-

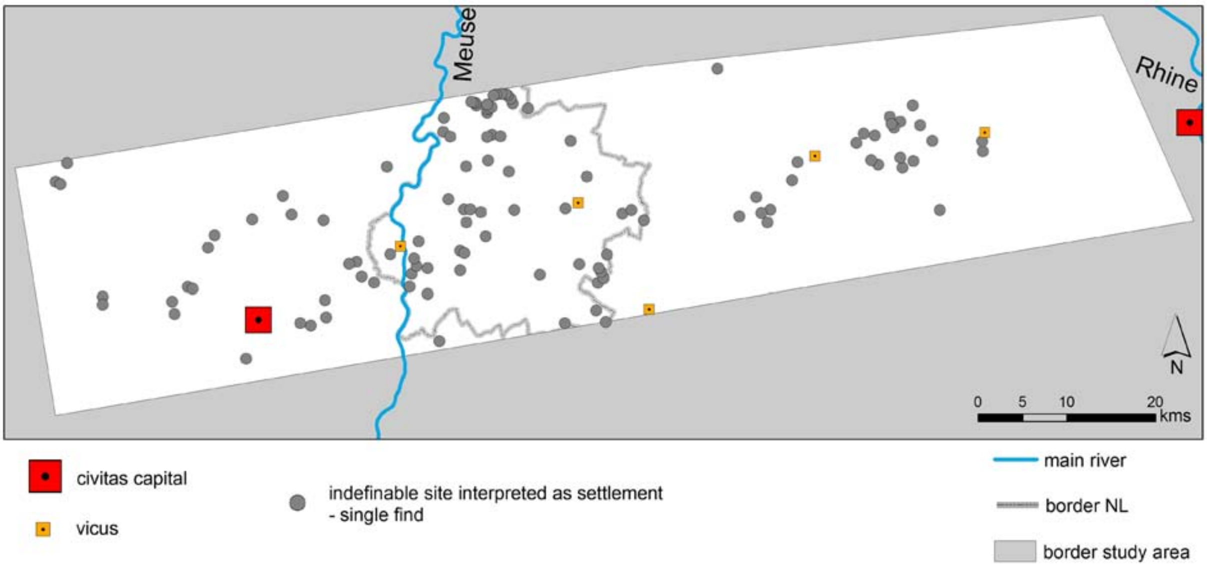


Fig. 5.14. Distribution of the 112 points from category 6 where one type of find material other than metal was recorded, that were reappraised as possible settlement evidence.

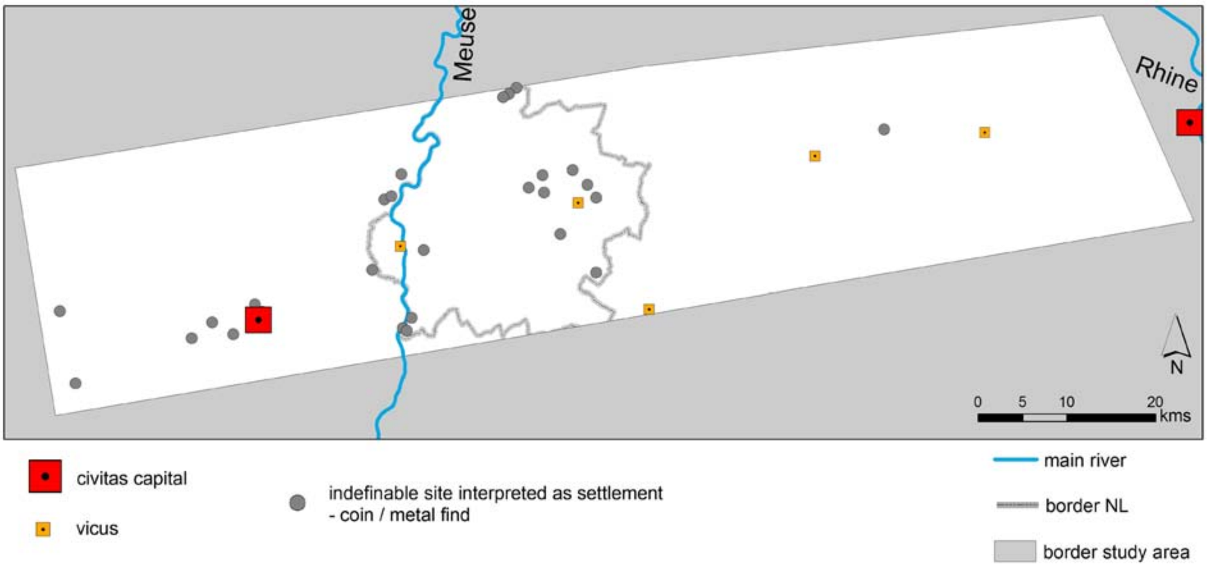


Fig. 5.15. Distribution of the 27 points from category 6 where metal was recorded, that were reappraised as possible settlement evidence.

tlements west of the Meuse is remarkable. These were *tumuli* for which the accompanying settlement remained unknown.

5.2.3 REAPPRAISAL OF THE INDEFINABLE EVIDENCE

Reappraisal of the settlement dataset resulted in a new dataset of 1186 sites. After adding evidence from the burial subset of data, this number was increased with 355 to 1541. The next subset of data that was examined was category 6, containing points with evidence that could not be defined according to the guidelines in this study. Using the method outlined earlier, it was established that 403 of the 714 points in category 6 could potentially be evidence of settlements. Of these 403 points 264 consisted of more than one type of find material, and 139 consisted of a single type (27 metal, 112 of another find material type). The total number of settlements in the reconstructed landscape thus increased from 1541 to 1944.

Because of the fact that there was no evidence of the use of stone as a building material at these sites and that the quantity of objects was generally quite humble, the sites re-interpreted as settlements could arguably be seen as representing the post-built type. Reappraisal of the 403 points from category 6 therefore resulted in a potential increase in the number of post-built settlements in the region from 27 to 430.

5.3 EXPLORING THE RECONSTRUCTED SETTLEMENT LANDSCAPES

The results of the reconstruction of the settlement landscapes will now be further examined, whereby the spatial distribution of the original and new sites will be focussed on. The results are described in texts and maps. The new datasets are presented in maps at a scale of 1:175.000, rather than the regular 1:400.000, in order to better appreciate the distribution of the new sites. This scale also means that soil type and waterways can be visualized without overcrowding the data. For this presentation the study region was divided into five micro-regions, as shown in figure 5.17.

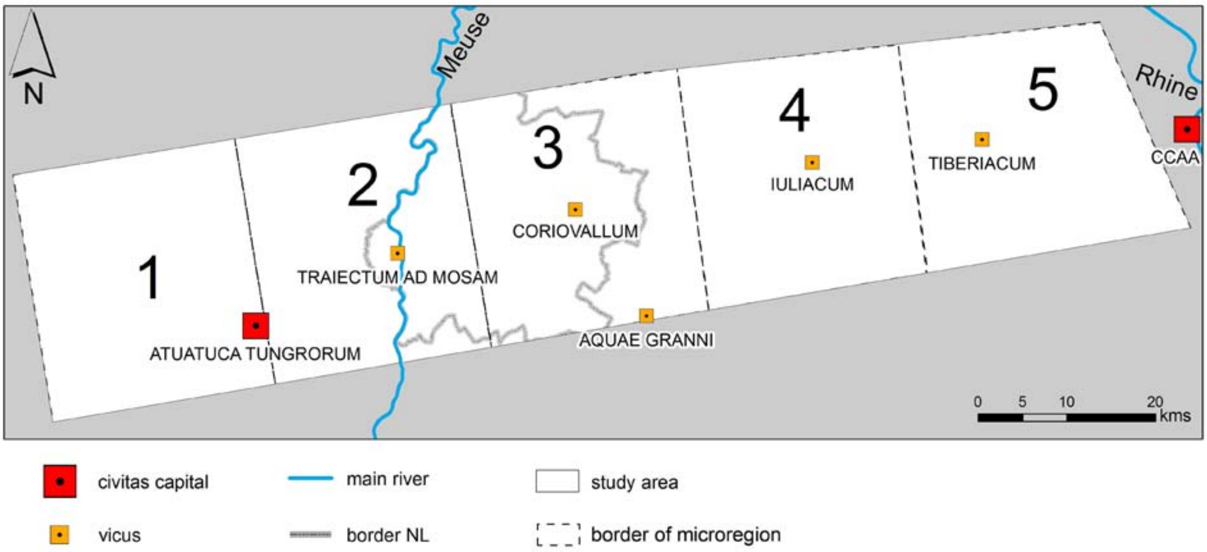


Fig. 5.16. Location of the five micro-regions defined for data presentation purposes.

5.3.1 MICRO-REGION 1

The first micro-region is located west of the Roman town of *Atuatuca Tungrorum*. In the original dataset, there were 67 sites classified as rural settlements there, all of which were characterised as 'stone-built'.

Reappraisal of category 1 sites resulted in the identification of 60 rural settlements, all of which were of the stone-built type. From the burial evidence, 8 regular burials, 29 tumuli and 2 regular and monumental burials complied with the criteria to be interpreted as settlements. This meant that 31 extra settlements were characterised as stone-built, and 8 as 'undefined'. From category 6, 30 sites

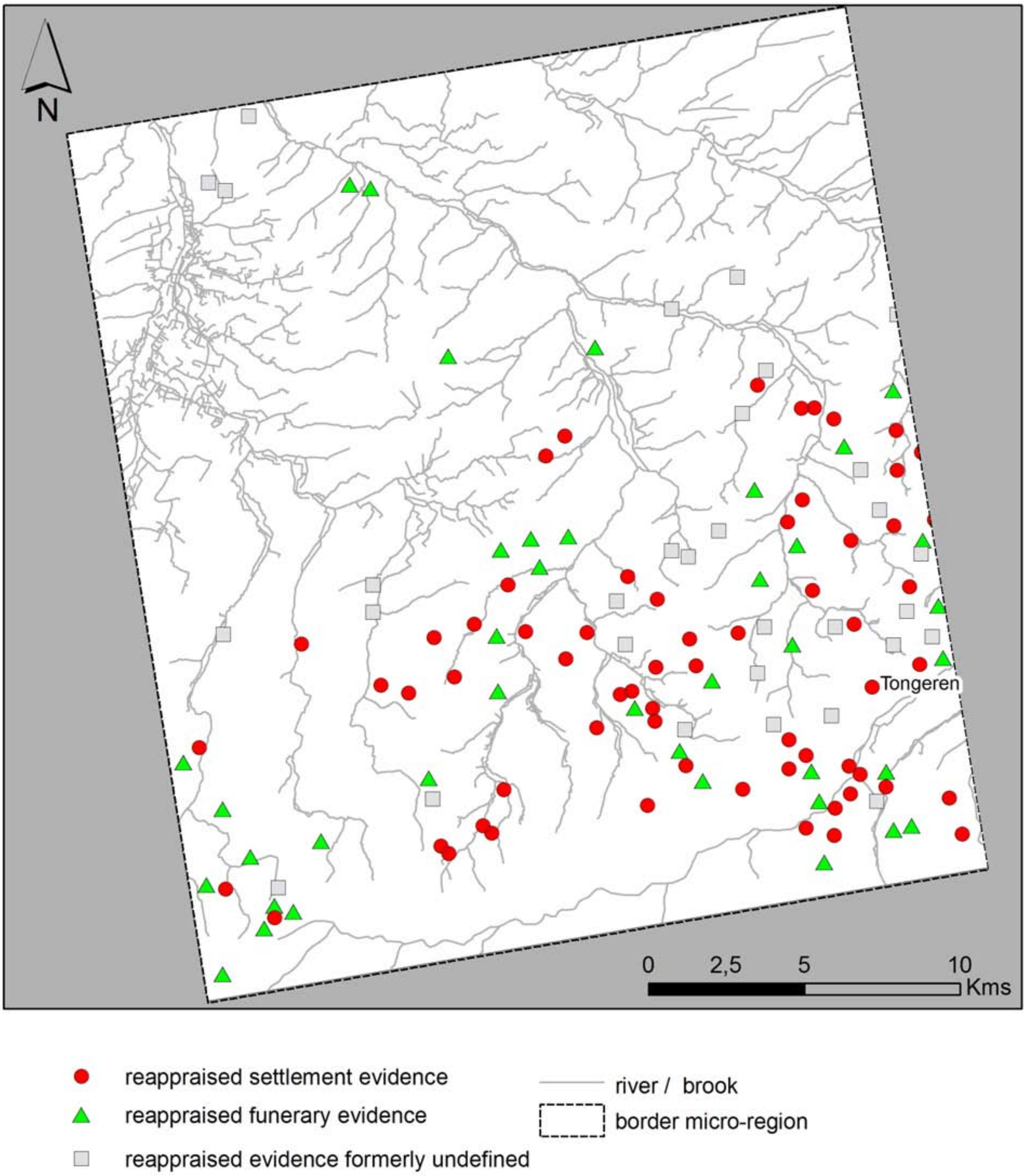


Fig. 5.17 Results of the reappraisal of data in micro-region 1.

complied with the criteria, 11 of which consisted of more than one type of find material, in addition to 12 single finds and 7 coin/metal finds. These 30 settlements have been interpreted as of the post-built type. The reconstructed settlement dataset for micro-region 1 thus consisted of 129 settlement sites. To summarise, the reappraisal of the evidence in categories 1, 2 and 6 gives the following results for micro-region 1:

- Settlement – stone-built: 91 (=71%)
- Settlement – post-built: 30 (=23%)
- Settlement – undefined: 8 (=6%)

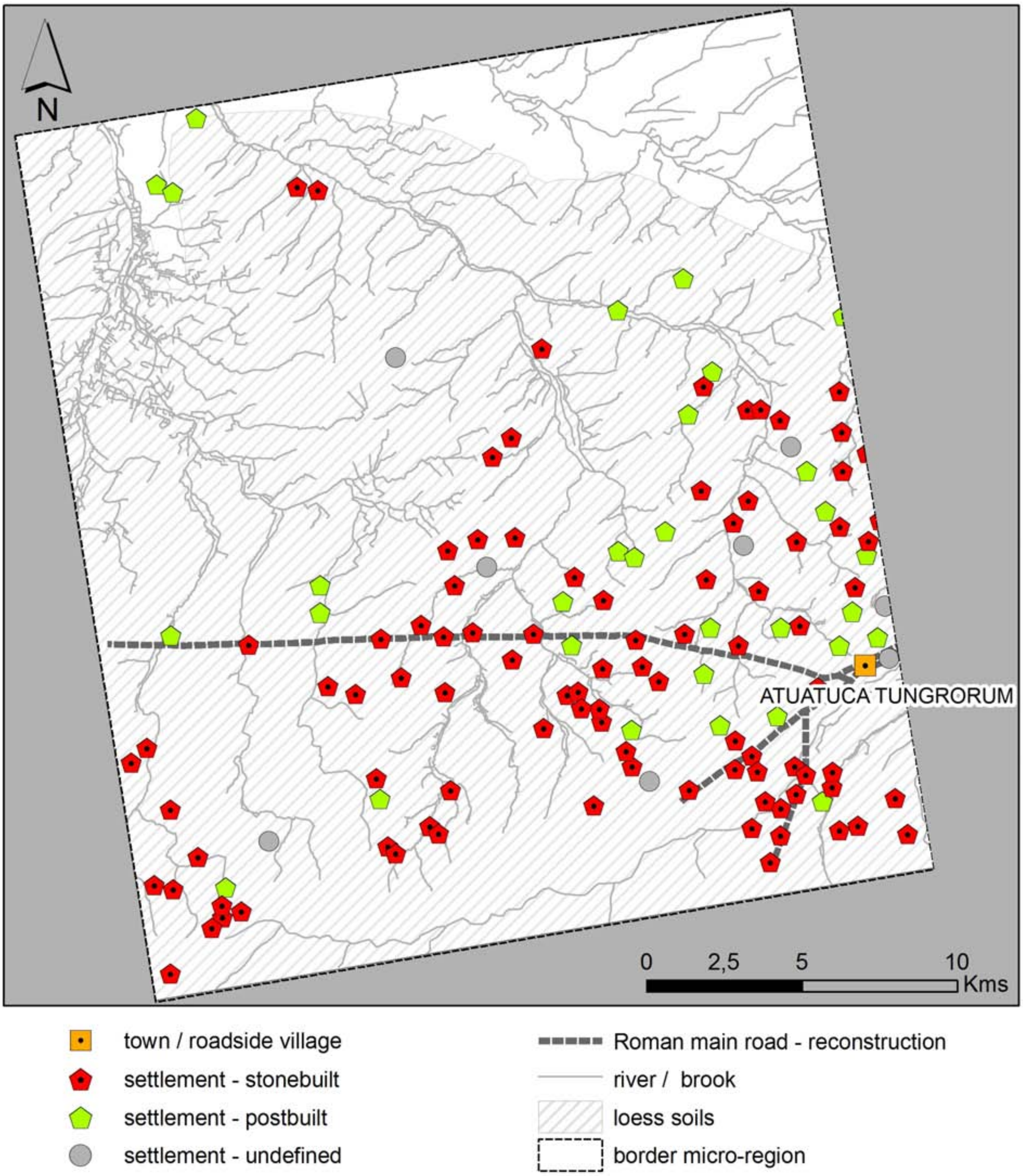


Fig. 5.18 The reconstructed settlement landscape of micro-region 1, with 129 sites.

From these numbers it can be concluded that in micro-region 1 the stone-built settlements outweighed the post-built settlements at approximately 3 :1. Even when the undefined sites are interpreted as post-built settlements, the proportions would still be 7:3 in favor of stone-built settlements. It is also important to point out that none of the post-built sites were dated to the early Roman period. The distribution of the new dataset is shown in figures 5.17 and 5.18.

The distribution of the different types of (rural) settlements, shown in figure 5.19, allowed for the identification of certain patterns and trends. Both stone-built and post-built settlements seemed to have be located throughout the area, without any obvious clustering of a specific type, with the exception of the area southwest of the urban centre of *Atuatuca* where a clustering of stone-built sites was found, with very few post-built settlements in the near vicinity.

The second, clearly discernible, pattern is that most sites were located in the southern half of the region. The reason for this could very well be caused by the physical environment in this micro-region. The northwestern part of the area is characterised by lower-lying, so-called 'wet loess' soils, with sandy soils in the central northern part, whereas the southern area contains regular loess soils. Observing the settlement distribution on the different soil types shows that on the sandy soils no settlements were recorded at all, and that just a few settlements were discovered in the region with the 'humid loess' soil type. In the following chapter the preference of location with regards to the physical environment will be analysed in detail.

Of the 129 settlements, 85% were not dated precisely. The 20 dated settlements can be used to reconstruct the following chronology: 7 settlements (28%) in the early Roman period, 13 settlements (52%) in the middle Roman period, and 5 (20%) in the late Roman period. [5]

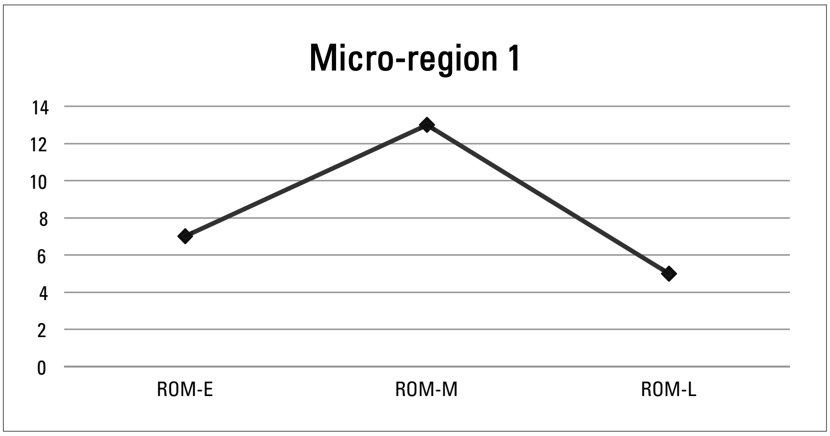


Chart 5.1 Chronology of the settlement landscape in micro-region 1.

5.3.2 MICRO-REGION 2

The second micro-region is located between the Roman towns of *Atuatuca Tungrorum* and *Traiectum ad Mosam*. The original dataset contained 133 sites classified as settlement evidence: 1 *vicus*, 117 stone-built rural sites and 15 post-built sites. Applying the method to category 1 sites resulted in 125 settlements: 1 *vicus*, 112 stone-built and 12 post-built rural settlements. From category 2, 34 regular burials, 16 *tumuli*, 2 monumental burial markers and 1 regular and monumental burial were re-interpreted as settlements. A total of 73 points from category 6 were also re-interpreted, 33 consisting of two or more types of find material, 8 coin/metal finds and 32 single finds of material other than metal. This means that 126 additional settlements were identified in micro-region 2, bringing the total number of settlements to 251. These sites were interpreted at level 3 as follows:

- Settlement – stone-built: 131 (=52%)
- Settlement – post-built: 85 (=34%)
- Settlement – undefined: 34 (=14%)

[5] In this chapter the dating information is used to reconstruct the chronology of each micro-region. Rather than presenting the dating information of each individual settlement, the dating information was used to reconstruct the number of settlements per period. This means that settlements dated as 'early – middle Roman' are counted for both the early and middle Roman period.

The use of non-settlement data to reconstruct the settlement landscape in micro-region 2 has resulted in a shift in the proportion of stone-built to post-built sites, from 8:1 to 3:2. Using this information, post-built settlements were more common in this landscape than in micro-region 1. When the points from category 6 are interpreted as post-built settlements, the proportion of both types becomes almost equal.

Of the 251 settlements, 73% could not be precisely dated. The 69 dated settlements provided the following information regarding the chronology of the micro-region: 29 settlements (37%) in the early

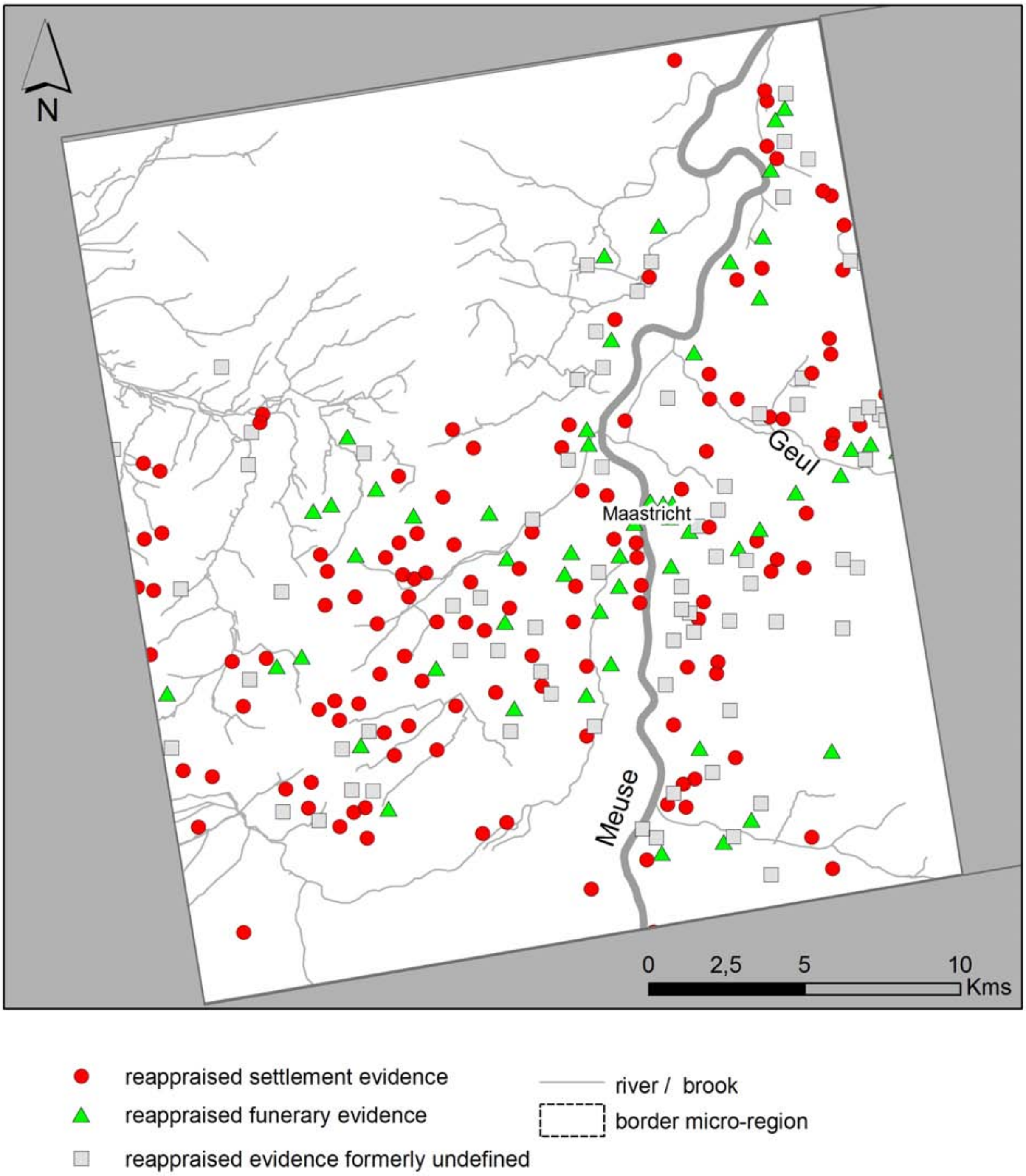


Fig. 5.19 Results of the reappraisal of data in micro-region 2.

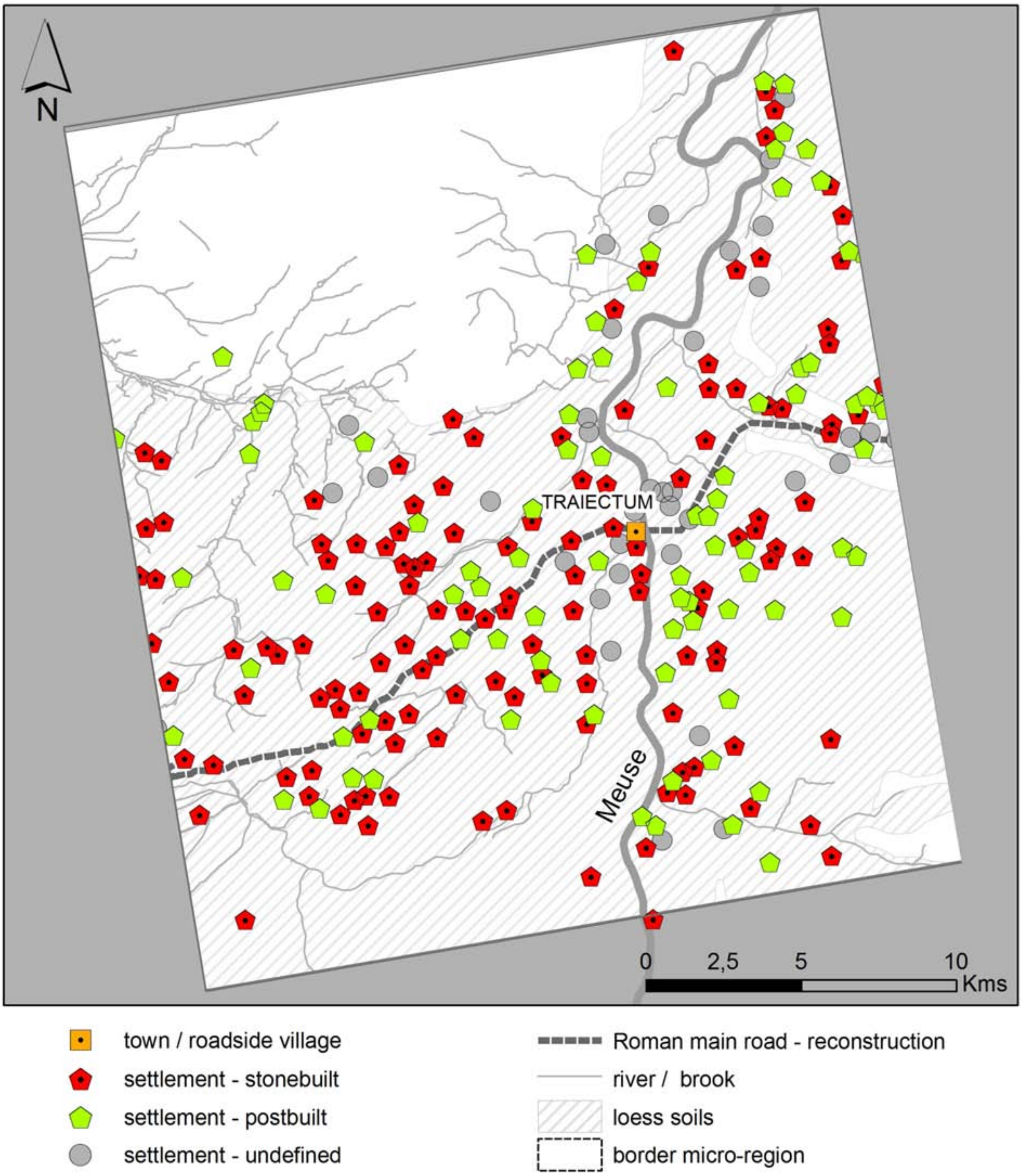


Fig. 5.20. The reconstructed settlement landscape of micro-region 2 with 251 sites.

Roman period, 38 settlements (48%) in the middle Roman period, and 12 (15%) in the late Roman period. Interestingly, post-built settlements are attested in both the early and the middle Roman periods.

In a situation comparable to that of micro-region 1, there was virtually no settlement on the sandy soils in the northern part of the micro-region, with both stone-built and post-built settlements seeming to favour the fertile loess soils. In this region too, there seems to be little evidence for the assumption that the loess plains were reserved for (richer) stone-built settlements, leaving the more marginal areas such as the Meuse valleys to (poorer) post-built settlements.

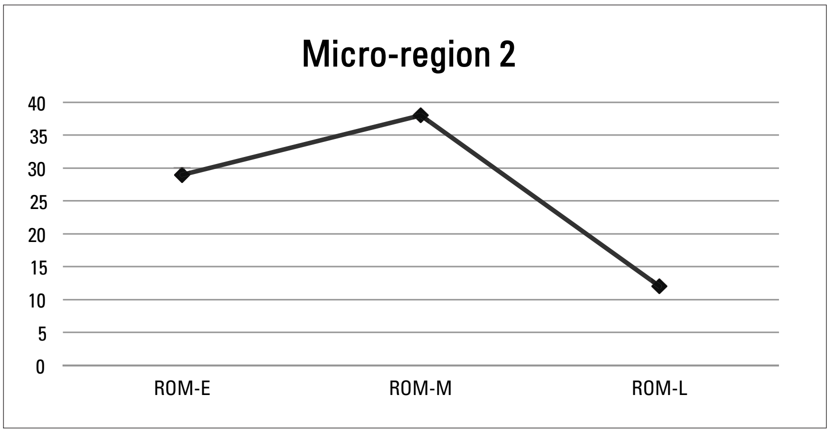


Chart 5.2 Chronology of the settlement landscape in micro-region 2.

5.3.3 MICRO-REGION 3

At the heart of micro-region 3 was the *vicus* of *Coriovallum*. Originally this region contained 192 sites with settlement evidence: 183 of the stone-built type, 5 post-built, and 4 with evidence of a town/village. After revision, 181 settlements were left, in which the 174 stone-built sites strongly outnumbered the 3 post-built settlements. The reappraisal of the funerary evidence for this micro-region resulted in the re-interpretation of 82 burial points: 71 regular burials, 2 *tumuli*, 3 monumental burial markers, 3 large stone incinerary urns and 3 sites with both regular and monumental funerary evidence. Revising the points of category 6 resulted in another 88 settlements. Of these 88 points, 35 consisted of two or more types of find material, 11 single finds of metal, and 42 single finds of other types of material.

Adding the new settlement points to the reappraised settlement dataset of 183 items increased the total number of settlements in micro-region 3 to 351. Apart from the 4 towns / roadside villages, these sites were divided over the different rural types as follows:

- Settlement – stone-built: 185 (=53%)
- Settlement – post-built: 91 (=26%)
- Settlement – undefined: 71 (=21%)

As in the previous micro-region, the use of non-settlement data to reconstruct the settlement landscape has resulted in a shift in the proportion of stone-built to post-built sites in micro-region 3, from 37:1 to the new proportion of 2:1. When the ‘undefined’ sites are interpreted as post-built settlements, the proportion of both types is almost equal.

78% of all settlements in this micro-region could not be precisely dated. The dated settlements were as follows: 15 in the early Roman period (18%), 54 in the middle Roman period (70%), and 10 in the late Roman period (12%). Due to a lack of detailed dating information for the majority of the post-built settlements it could not be established whether they were present at the same time as the stone-built settlements.

The distribution map of this micro-region (see figure 5.22) reveals that, generally, both rural settlement types seem to have been distributed quite evenly across the area, although a clustering of post-built sites was located in the northwest of the area, and a clustering of stone-built settlements can be detected in the northeast. Although the sandy soils in the north were distinctly less densely populated, the fact that some stone-built settlements were found here seems to contradict the assumption derived from the previous two micro-regions that these marginal areas were avoided completely by settlers. In the south of this micro-region slopes are steeper and therefore the loess soils here suffer from strong soil erosion, which leaves the rocky substrate exposed or very close to the surface. This area seems to have been avoided in the Roman period, as settlement density here appears to have been lower than the more northern parts.

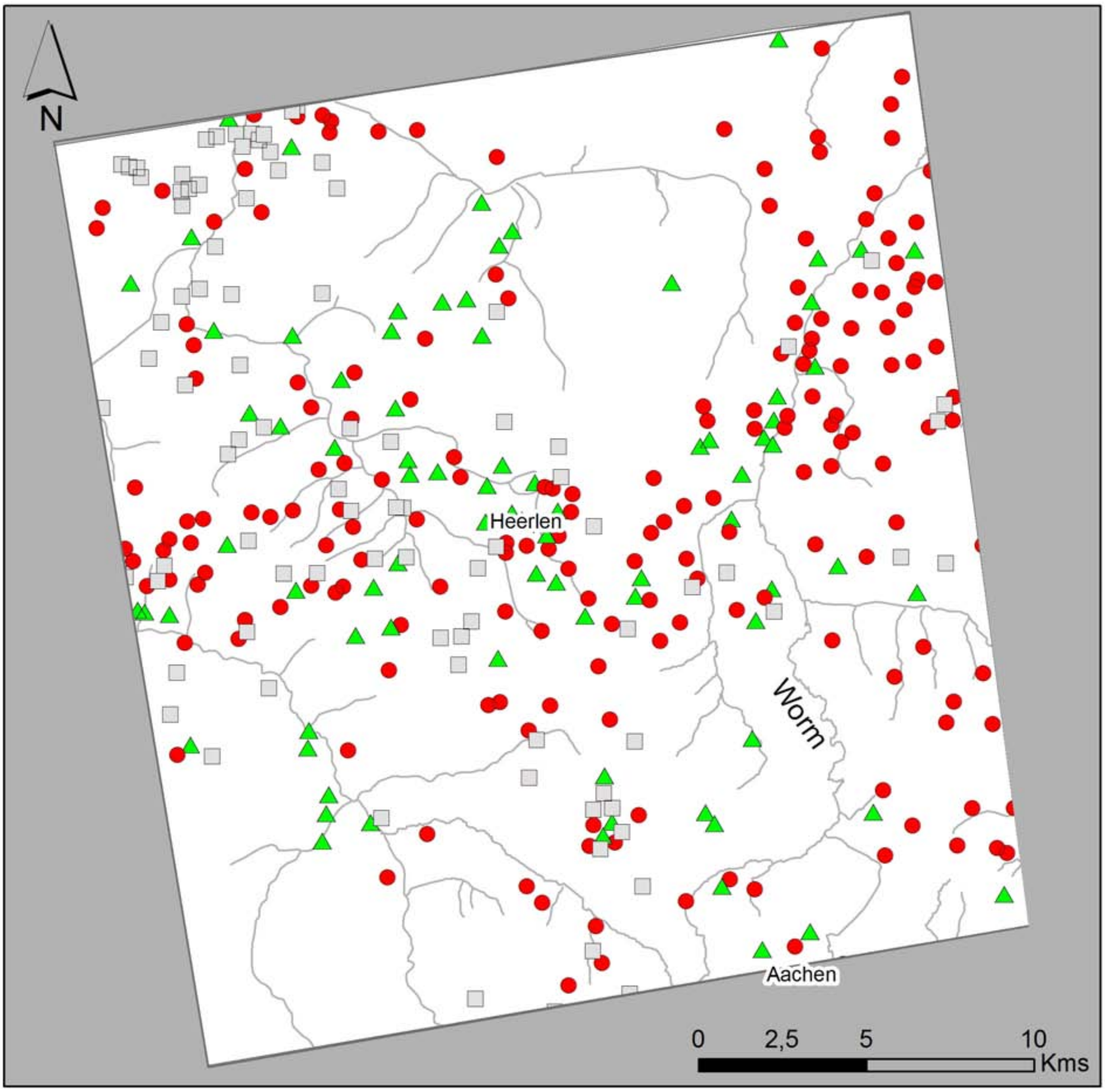


Fig. 5.21. Results of the reappraisal of data in micro-region 3.

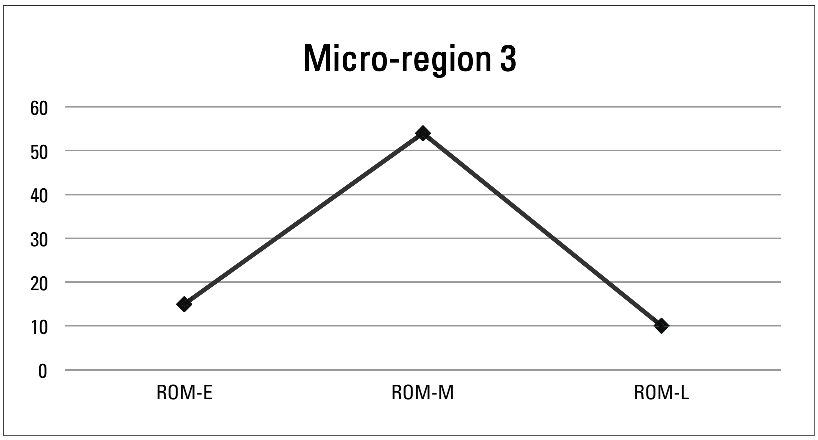


Chart 5.3 Chronology of the settlement landscape in micro-region 3.

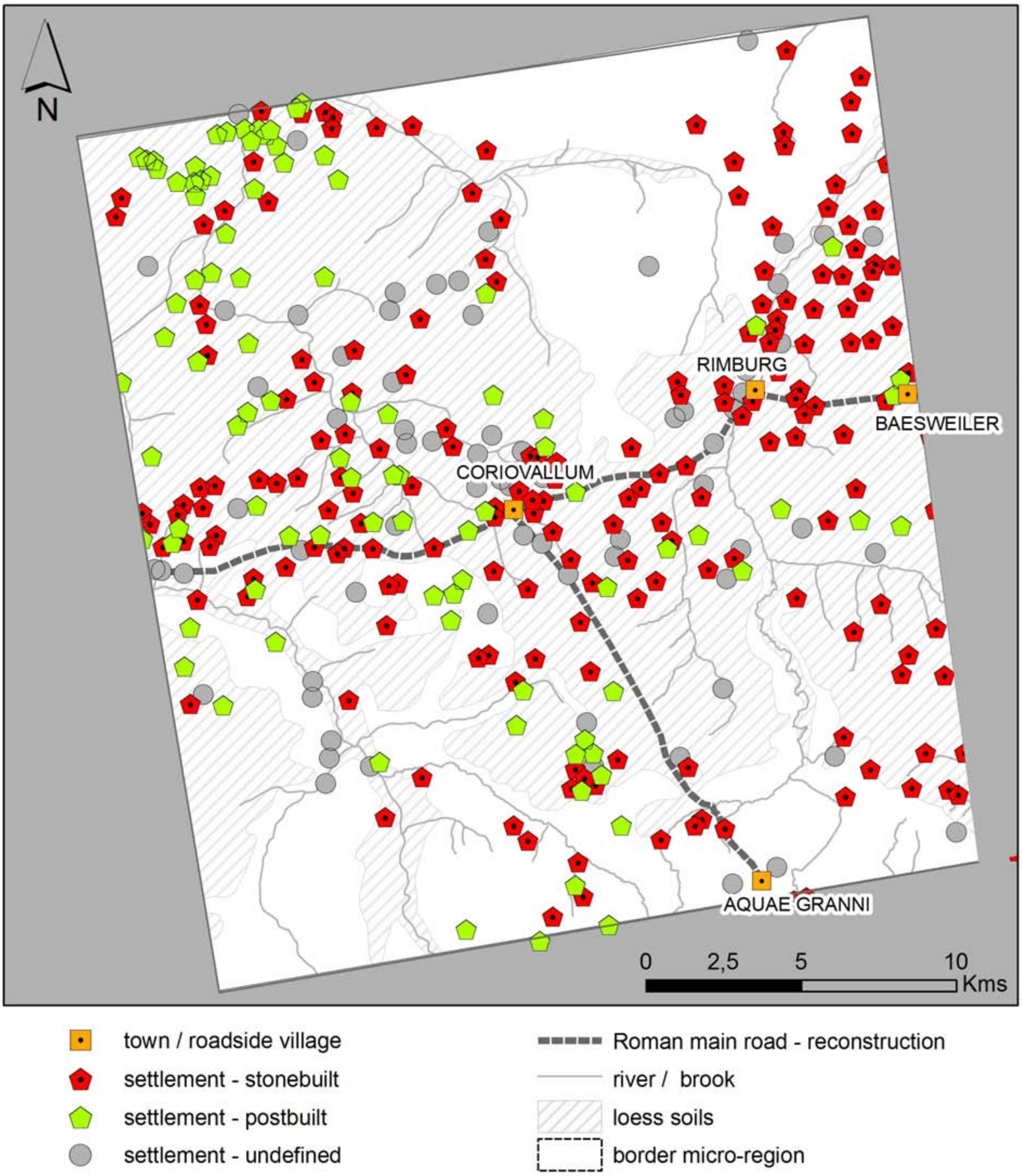


Fig. 5.22 The reconstructed settlement landscape of micro-region with 351 sites.

5.3.4 MICRO-REGION 4

Micro-region 4, with the *vicus* of *Iuliacum* at its centre, had the highest settlement density of the entire study area, with a total of 591 sites in category 1. At level 3 of interpretation, 572 of these sites were characterised as rural stone-built, 17 as rural post-built, and 2 as *vicus* / roadside village. After reappraisal of category 1 the number of settlements was 528: 2 *vici* / roadside villages, 512 stone-built and 11 post-built rural settlements. The reappraisal also led to the discovery of 3 sites with a 'concentration

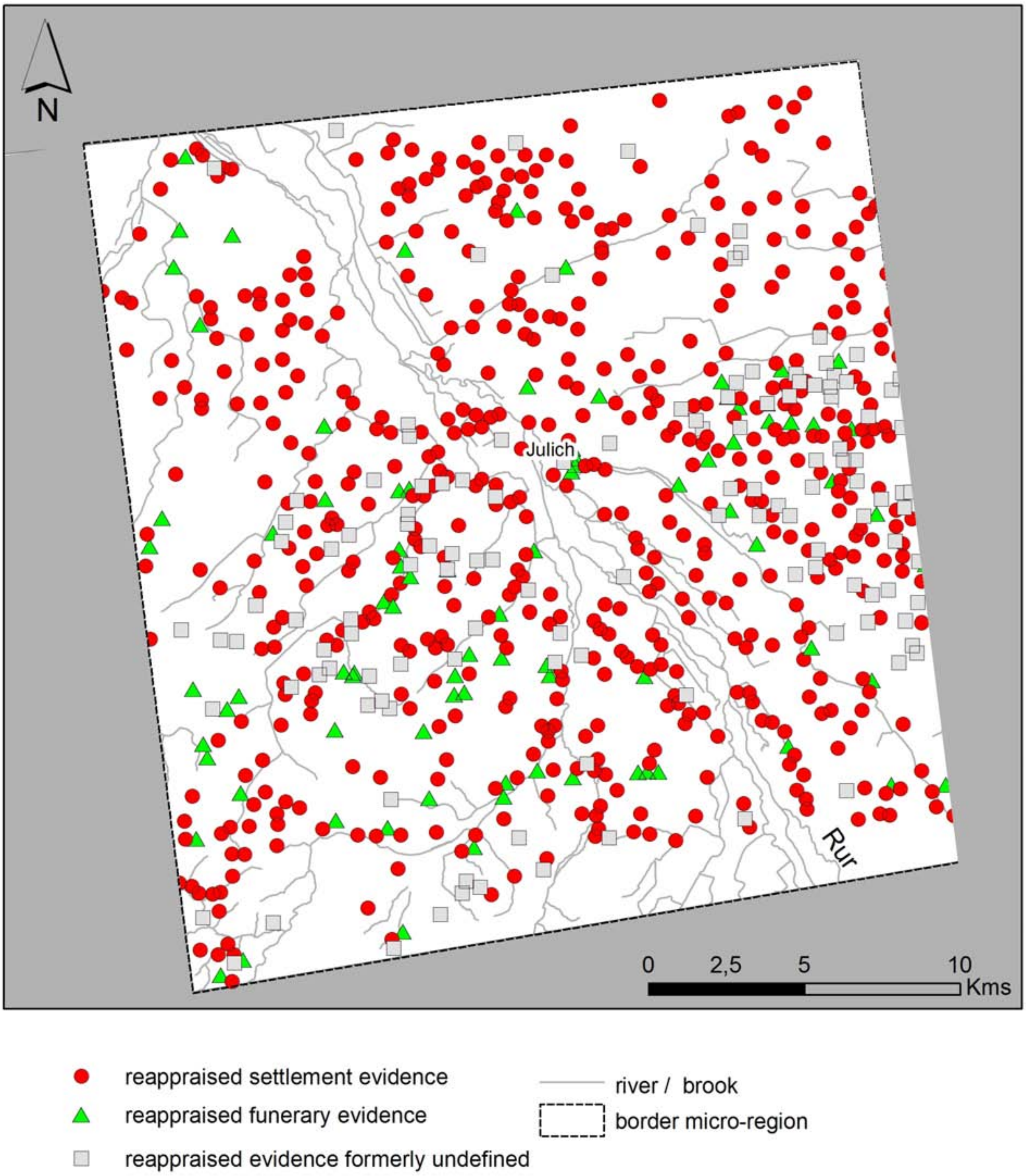


Fig. 5.23 Results of the reappraisal of data in micro-region 4.

of habitation'. Revision of the funeral evidence in this area resulted in the re-interpretation of 86 sites as settlements: 75 regular burials, 1 monumental burial marker, 7 large stone incinerary urns and 3 locations with both regular and monumental burials. These results increased the number of stone-built settlements by 11 to 523. The reassessment of category 6 led to the re-interpretation of 128 sites: 1 single find -metal, 20 single finds – other material and an impressive 107 points with at least 2 types of find material.

Following the assumption that sites based on evidence in category 6 represents post-built settlements, the reappraisal resulted in an increase of this type from 11 to 139.

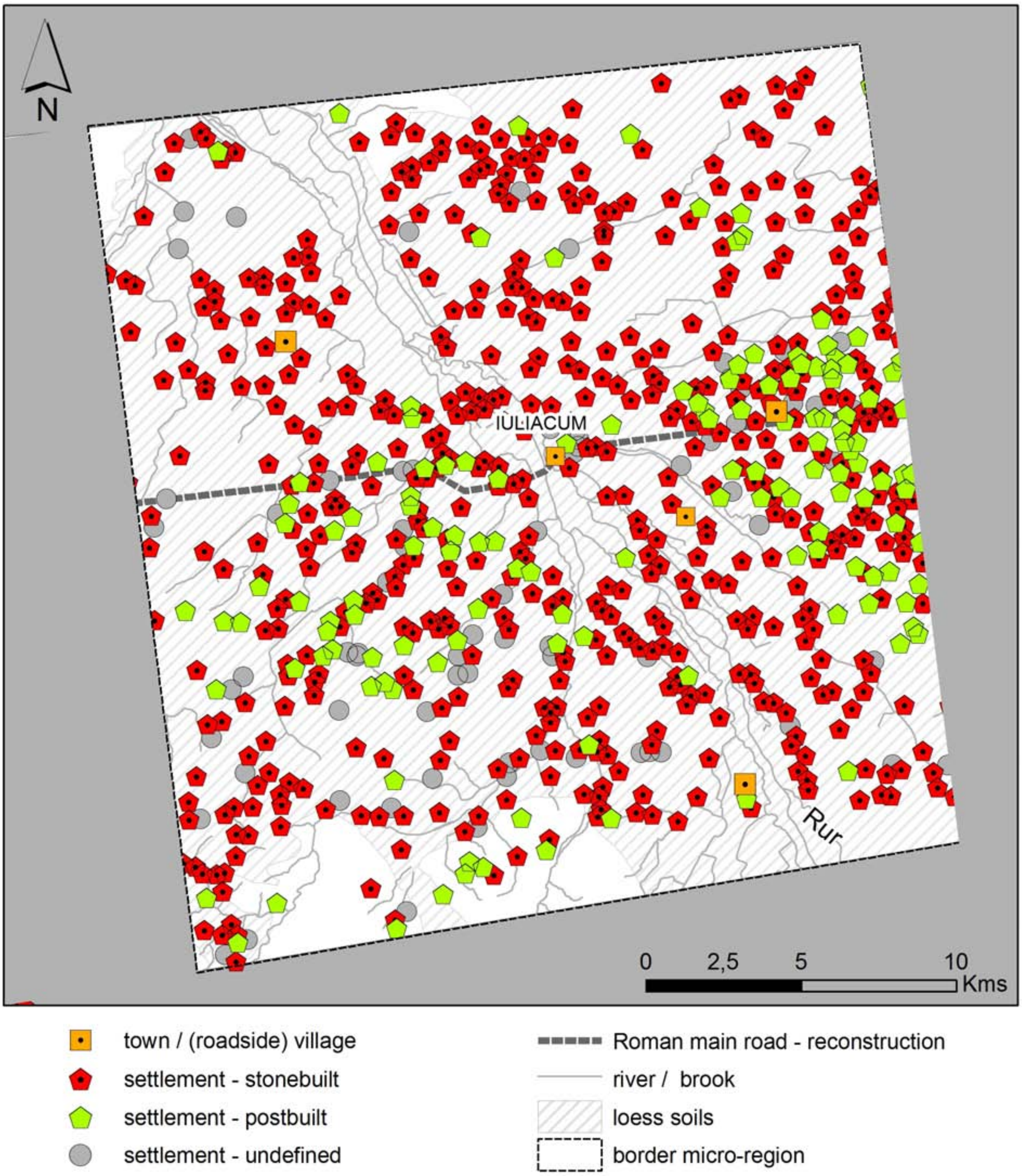


Fig. 5.24 The reconstructed settlement landscape of micro-region 4 with 742 sites.

The application of the reconstruction method has resulted in an increase in the number of settlements in this region to an overall total of 742. Five of these settlements had an urban / conglomerated character; the remaining 737 settlements are characterised at level 3 as follows:

- Settlement – stone-built: 523 (=71%)
- Settlement – post-built: 139 (=19%)
- Settlement – undefined: 75 (=10%)

The numbers show that, in micro-region 4, stone-built rural settlements remain the most dominant form, even when other types of evidence are taken into consideration. Although the shift in propor-

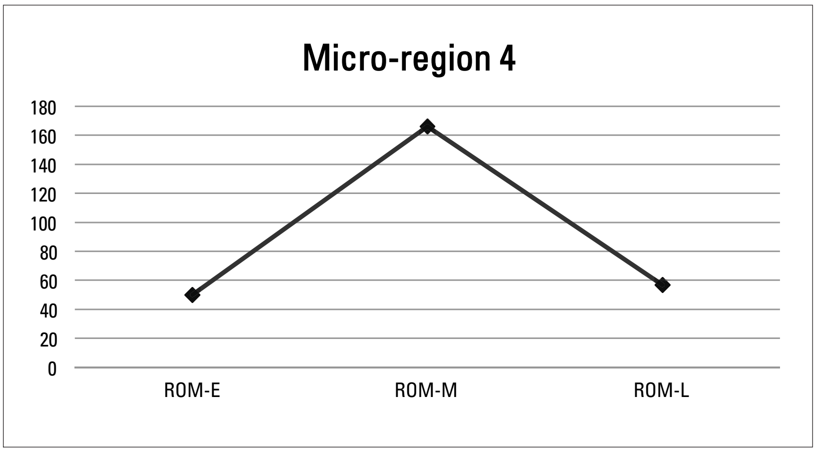


Chart 5.4 Chronology of the settlement landscape in micro-region 4.

tion has changed considerably, from 34:1 to 4:1, the numbers remain in favor of stone-built sites. When the 75 'settlement-undefined' sites are interpreted as post-built settlements, the proportions change to 5:2.

Figures 5.23 and 5.24 show that most of micro-region 4 consists of loess soils. Only in the far south do these soils give way to the rocky underground of the foothills of the Eifel mountain range. The Rur river, located in the centre of this micro-region, has carved out a substantial valley, nearly 2.5 kms wide, whose floor is covered by alluvial deposits. The distribution maps show that settlements are found everywhere, including on the valley floor and on the foothills of the Eifel.

In total, 74% of the settlements in this micro-region were not precisely dated. The dated settlements showed the following chronological development: 50 settlements in the early Roman period (18%), 166 in the middle Roman period (61%), and 57 (21%) in the late Roman period.

Of the 11 post-built settlements, 10 were dated to the early or early to middle Roman period. The majority of the 'settlement-undefined' sites are not precisely dated, however. More information is needed to ascertain whether the post-built settlements existed at the same time as the stone-built settlements or whether they preceded them.

5.3.5 MICRO-REGION 5

Micro-region 5 is located in the east of the study area and closest to the *limes*. The region lies in the hinterland of the civitas capital of *Colonia Claudia Ara Agrippinensium*, with the *vicus* of *Tiberiacum* at its centre. In the original dataset 313 sites were registered in category 1: 3 *vici* / roadside villages, 307 rural settlements of the stone-built type and 3 of the post-built type. After revision, no post-built settlements remained, and the number of stone-built settlements was reduced to 286. Using the funeral evidence, 95 sites were reinterpreted as settlements: 74 regular burials, 1 tumulus, 1 monumental burial marker, 17 large stone incinerary urns and 2 sites with both regular and monumental burial material. This increased the number of stone-built rural settlements with 21. The reappraisal of points of category 6 increased the number of settlements in this region to 83, with 77 points consisting of two or more types of find material and 6 single finds. Adding the new sites to the revised settlement dataset brought the total number of settlements in micro-region 5 to 467. Apart from the three towns / villages, they are divided over the different types as follows:

- Settlement – stone-built: 307 (=66%)
- Settlement – post-built: 83 (=18%)
- Settlement – undefined: 74 (=16%)

Re-interpreting the evidence in categories 1, 2 and 6 has resulted in a shift in the proportion of stone-built to post-built settlements from 95:1 to 4:1. When the 'settlement-undefined' data is interpreted as post-built settlements, the proportion changes to 2:1.

Of the 467 settlements, 155 were precisely dated. This information enables a reconstruction with 23 settlements (11%) in the early Roman period, 130 (62%) in the middle Roman period, and 57 (27%) in the late Roman period.

Unfortunately very few of the post-built settlements were dated precisely, therefore it was impossible to ascertain whether or not they were contemporaneous with the stone-built sites.

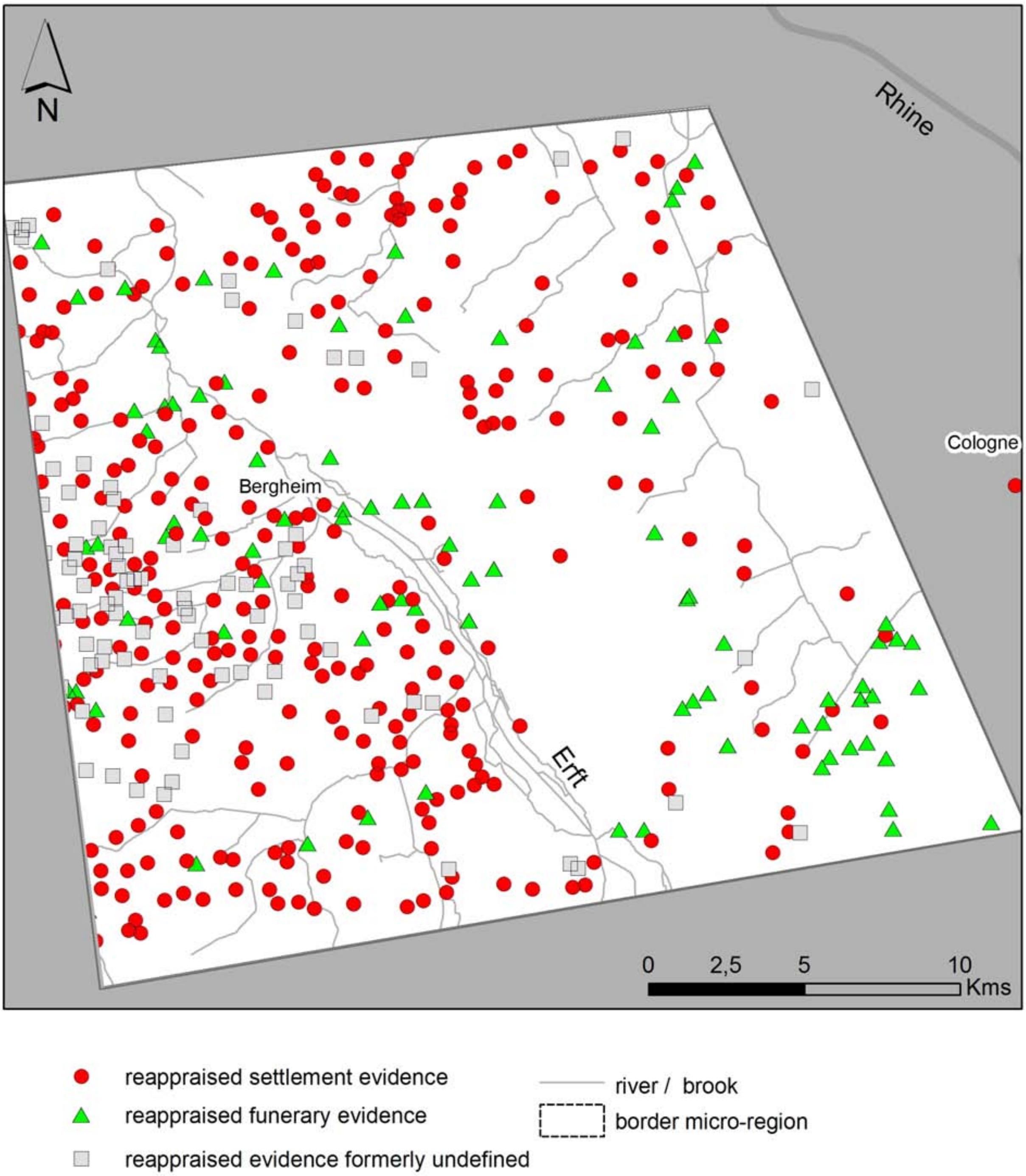


Fig. 5.25 Results of the reappraisal of data in micro-region 5.

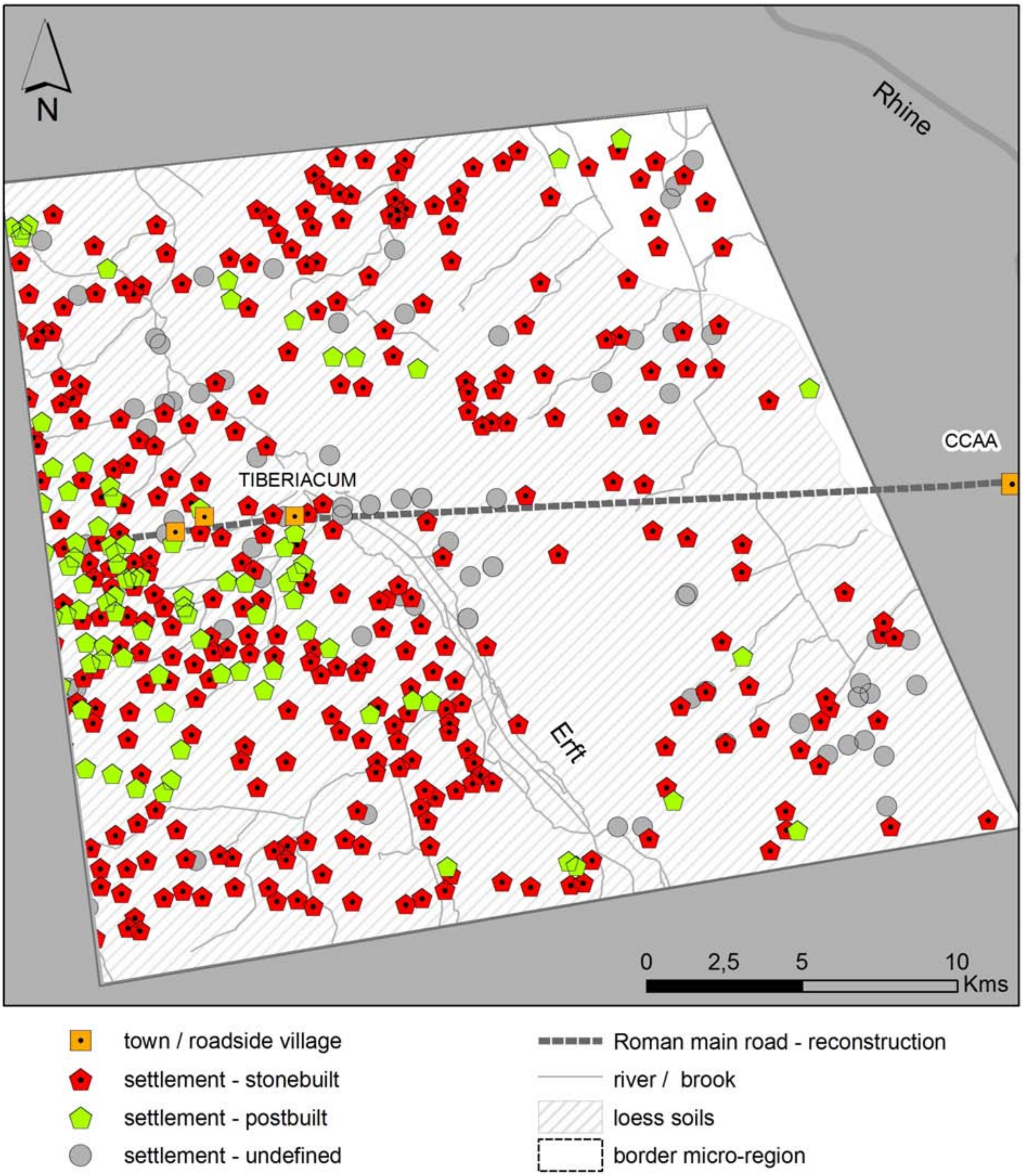


Fig. 5.26 The reconstructed settlement landscape of micro-region 5 with 467 sites.

Like micro-region 4, micro-region 5 is almost entirely covered in loess soils. The river Erft flows down its centre. The distribution map shows that the majority of settlements seemed to be located west of the Erft, whereas post-built settlements seemed to appear almost exclusively here.

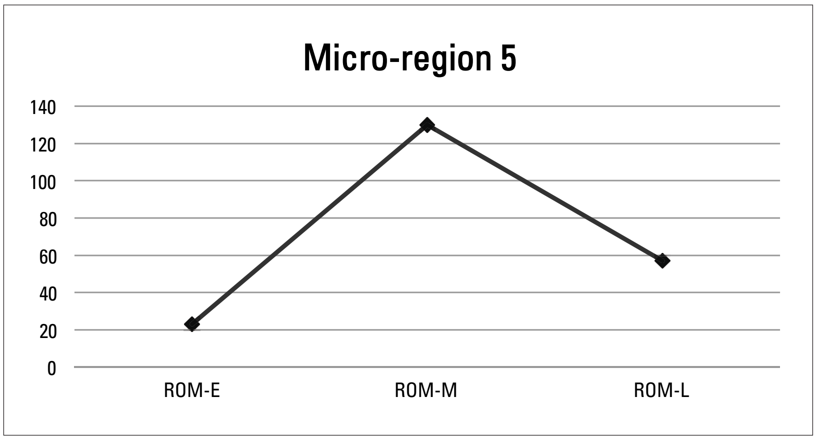


Chart 5.5 Chronology of the settlement landscape in micro-region 5.

5.3.6 OBSERVATIONS AND CONCLUSIONS

1. The re-interpretation of the basic dataset using the model has thus resulted in three new datasets:
2. The revised settlement dataset, consisting of 1186 sites (from now on referred to as n=1186);
3. The revised settlement dataset plus funerary evidence re-interpreted as settlements, consisting of 1541 sites (from now on referred to as n=1541);

The revised settlement data plus funerary and formerly undefined evidence re-interpreted as settlements, consisting of 1944 sites (from now on referred to as n=1944).

The dataset n=1186 can be seen as the most 'reliable', as the items in it comply with the strictest criteria for a settlement set up it this study: evidence in the shape of house plans, building materials, and compliance with the defined spatial criteria. 99% of the dataset n=1186 consists of rural settlements, the remaining 1% being towns and villages. At interpretation level 3, 97% consists of stone-built rural settlements; 2% consists of post-built rural settlements.

The dataset n=1541 contains 355 extra settlements, the evidence for which consists of funerary material. Although for the majority of these additional sites the type (at level 3 of interpretation) could not be established, due to the nature of the funerary evidence. Taking this in account and assuming that the monumental burials are evidence of stone-built settlements, the dataset n=1541 is composed the following way: 1% urban settlements, 2% post-built rural settlements, 80% stone-built rural settlements and 17% 'settlement – undefined'. If, however, it is assumed that the regular burials represent post-built settlements, because of the lack of (discovered) settlement material nearby, this would mean that the composition of the rural settlement landscape becomes 80% stone-built versus 19% post-built.

The largest dataset, n=1944, could be perceived as being the least reliable of the three, because of the 'liberal' definition of settlement evidence. Nonetheless, if accepted, this dataset highlights a settlement pattern for the study area hereto overlooked by archaeologists because of a research bias towards Roman villas. Because each site in the dataset has been examined for the actual find materials and complies with the spatial criteria, it is believed that this scenario is not improbable. Clearly not every single find or surface find of some tile fragments was included. When the extra settlements are interpreted as being of the post-built type, the proportions for the different types in this category are as follows: 1% urban settlements, 64% stone-built settlements, 22% post-built settlements and 13% 'settlement-unknown'. Looking only at the rural landscape, when the 'type-unknown' settlements are interpreted as post-built, the proportions become 64% stone-built – 36% post-built. This means that even with the most extreme interpretation of sites, post-built rural settlements remain the smaller component of the rural landscape.

This has important implications, not just for the settlement landscape as a whole, but also for understanding the individual elements in it, specifically stone-built rural settlements. As already pointed out in the previous chapter, current definitions of the Roman villa all have an association with the

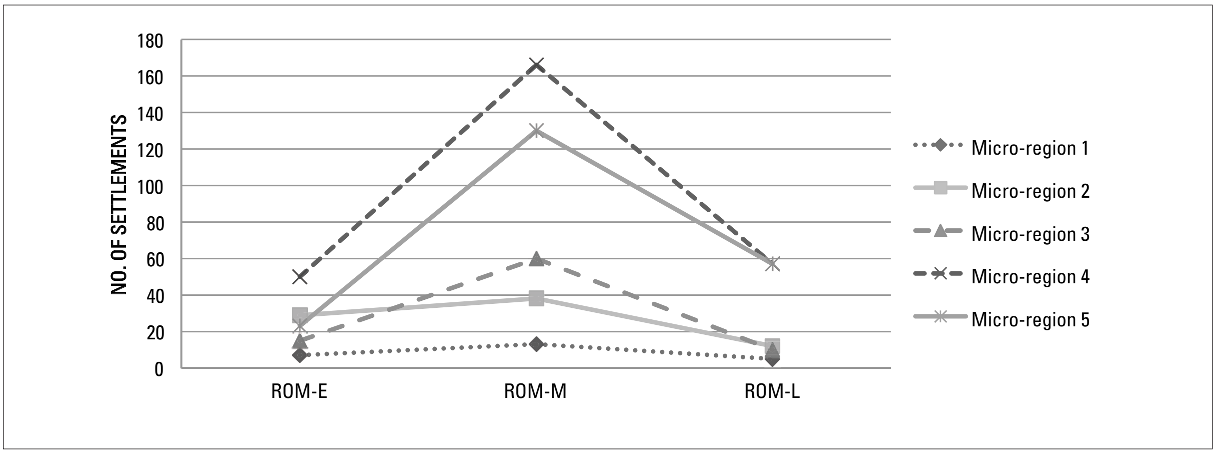


Chart 5.6 Comparison of the individual chronologies of the micro-regions, showing the absolute number of settlements per period.

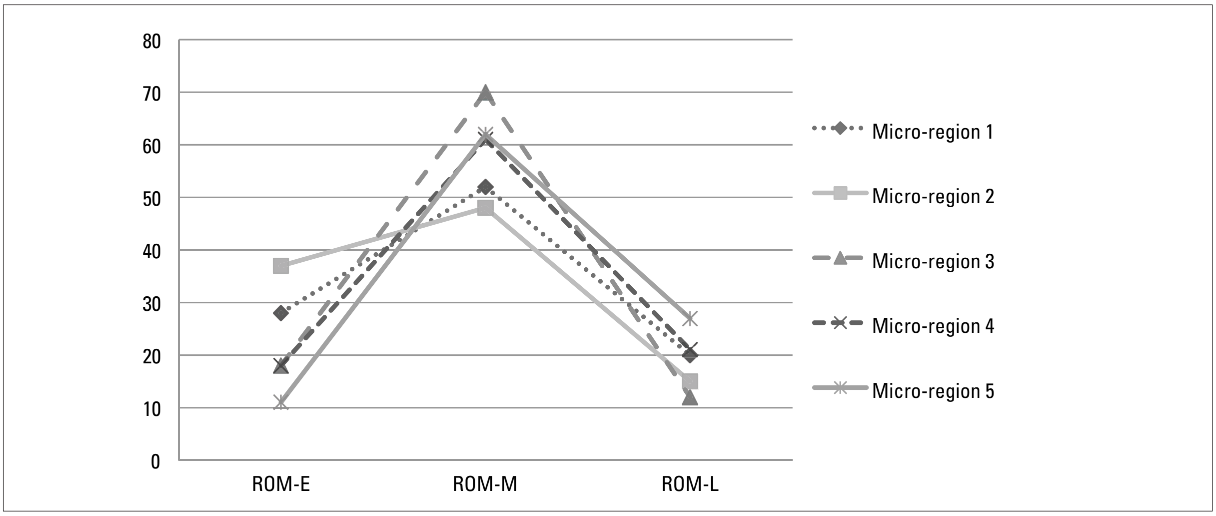


Chart 5.7 Comparison of the individual chronologies of the micro-regions, showing the percentages of settlements per period.

upper echelons of the provincial-Roman society in common, although several researchers have come up with alternative interpretations.[6] As 'elites' by definition only form a minority within society, their dwellings should also constitute a small proportion within the entire settlement landscape. The results of the reconstruction emphasize the need for a reconsideration of the assumptions regarding the status of particular types of settlements in the study area, and how they can be (archaeologically) recognized. For example, recent studies of settlement landscapes in present-day France offer good parallels for similar settlement hierarchy reconstructions.[7] In the previous chapter, the possibilities of multi-variable analysis in this respect have already been demonstrated.

Another important result of the reconstruction relates to the spatial distribution of the different types of rural settlement. The distribution maps showed that the two main settlement types highlighted by this study were found in the same areas. This is an important observation, as it has often

[6] Amongst others, Williamson 1989, 73, citing for example Smith 1978.

[7] See for example Nouvel 2009 and Nuniger 2002.

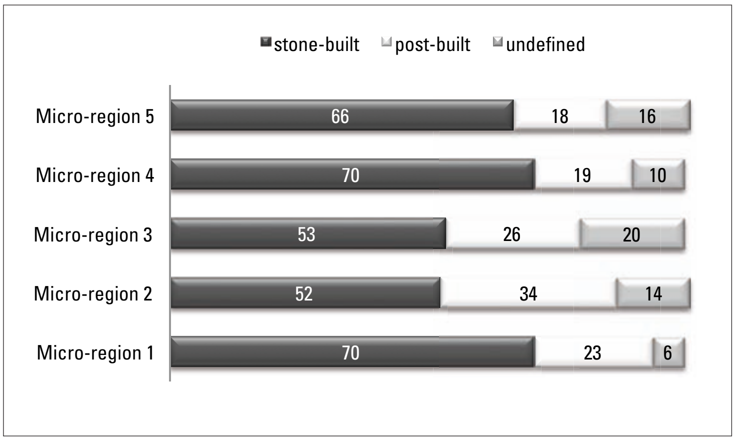


Chart 5.8 Comparison of the percentages of stone-built, post-built, and undefined settlements per micro-region.

been assumed that post-built settlements, thought to represent the less wealthy part of the landscape, were located mainly in the more marginal parts of a region, whereas the 'wealthy' stone-built settlements were expected in the prime agricultural areas. The distribution maps of the five micro-regions seem to suggest otherwise; a factor that is further examined in chapter 6.

The analysis of the five micro-regions has provided important clues to the interregional differences within the study area. The following charts visualise the chronologies of the five micro-regions, in absolute numbers (chart 5.6) and percentages (chart 5.7). These visualisations allow a comparison of micro-regional developments.

Analysis of the dated sites in the previous chapter showed the general trend of growth and decline in the study area. The individual micro-regions all demonstrated this pattern. Chart 5.6, however, is evidence of certain differences between the regions. The line representing micro-region 4 shows the steepest curve of the entire region, suggesting a rapid process of expansion and decline. Micro-region 1 shows the flattest curve, suggestive of more limited settlement dynamics in this part of the study area. A comparison of the values at the beginning and the end of the Roman era shows that in most regions settlement numbers in the late period were more or less at the same level as they were in the early period. However, two micro-regions show a different pattern. In micro-region 2, settlement numbers were higher in the early than in the late period; conversely in micro-region 5, settlement numbers were higher at the end of the Roman period than at the beginning. Chart 5.7 , visualising the percentages, shows these patterns even more clearly. Proportionally, micro-region 2 shows the highest number of settlements during the early period, the least increase in the middle Roman period, and almost the lowest number for the late period. Micro-region 5, on the other hand, has the lowest number in the early period, followed by a sharp increase in the middle Roman period, ending with proportionally the highest number of settlements in the late period.

Another source of information for settlement dynamics is the comparison of the different types of rural settlement between the five micro-regions. Chart 5.9, shows that, proportionally, micro-regions 1 and 4 had the highest number of stone-built settlements, whereas micro-regions 2 and 3 had the lowest number. If the undefined type of settlements is interpreted as post-built, the proportions of stone-built to post-built in micro-regions 2 and 3 would almost be 1:1. This demonstrates the variability of composition within the study area; new empirical data would be welcome to further explore this topic.

5.4 REVIEWING SETTLEMENT DENSITY

The next aspect of the settlement landscape to be explored was the settlement density. In ArcMap density maps were made for the two datasets (n=1186 and n=1944), shown below. The resultant raster datasets reflect the average density per square kilometre. As was to be expected, the dataset n=1944 resulted in a different map than dataset n=1186, but it was interesting that there were also similarities between the two in terms of the location of highest density of settlement.

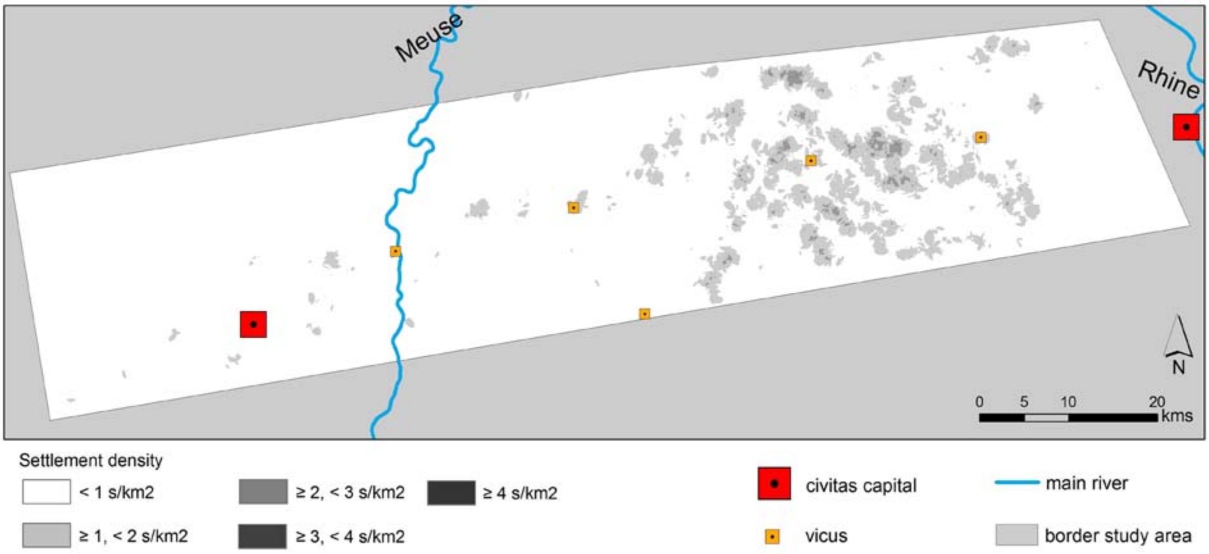


Fig. 5.27 Settlement density map based on the settlement dataset n=1186.

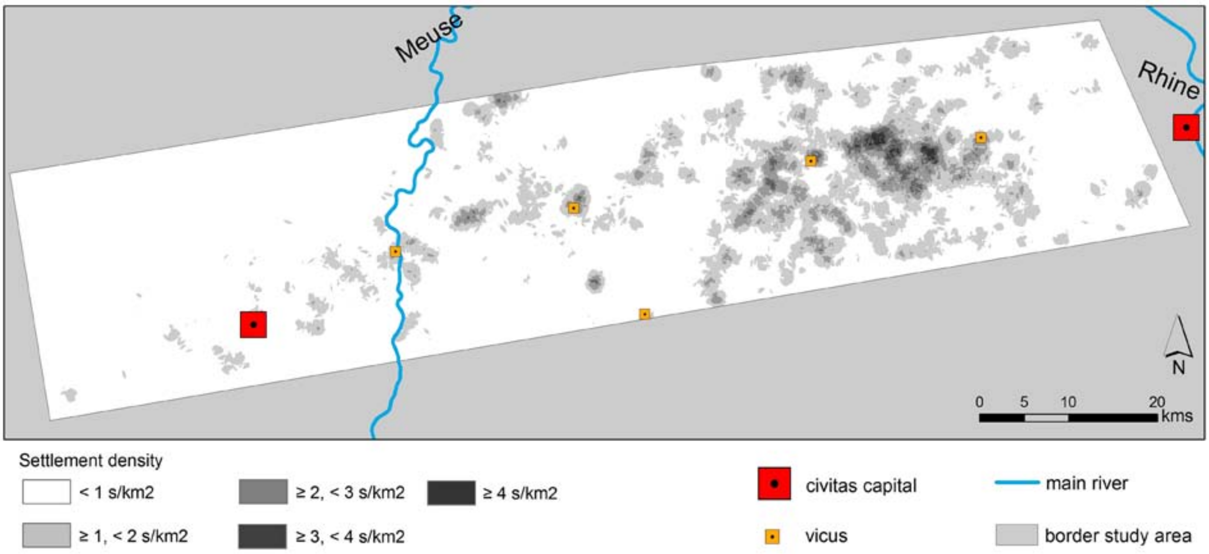


Fig. 5.28 Settlement density map based on the settlement dataset n=1944.

In both maps the general pattern seemed to be that the central-eastern part of the study area was more densely populated than the central-western part. The main question to answer was whether these patterns were a reliable reflection of the actual situation in the Roman period? If so, it could be expected to identify specific conditions in the areas of high settlement density that made those parts more attractive to Roman farmers. For example, environmental factors such as climate, soil type, the presence of water, and elevation determined the suitability of a region for farmers.[8] With this line of reasoning we should expect the highest density numbers where environmental conditions differed substantially from, and were demonstrably better than, those in areas with lower densities. Not just environmental factors influenced settlement location, as, for example, proximity to markets could also be considered a preferential circumstance. Below the location of specific environmental circumstances will be compared to the areas of high and low settlement density, in an attempt to establish whether indeed specific circumstances are present at areas of high settlement density. Statistical analyses of the perceived influence of environmental factors on settlement patterns will be presented in the next chapter.

5.4.1 The natural environment

Figure 5.29 indicates roughly the area where the fertile loess soils are found. It would be expected that areas of low settlement density would coincide with areas without loess soils. Looking at the map, it seems that settlement density is low everywhere outside of the loess zone, with the notable exception of the north-eastern corner of the study area. However, within the loess zone there are noticeable differences in settlement density and large areas can be identified where the density is lower than 1 site per square kilometre, whether based on the n=1944 or on the n=1186 dataset. Presence or absence of loess soils alone then seems insufficient to explain the differences in settlement numbers.

Another important element in a farming environment is water. Figure 5.30 shows the most important rivers and streams in the study area. It is assumed that proximity to (running) water was impor-

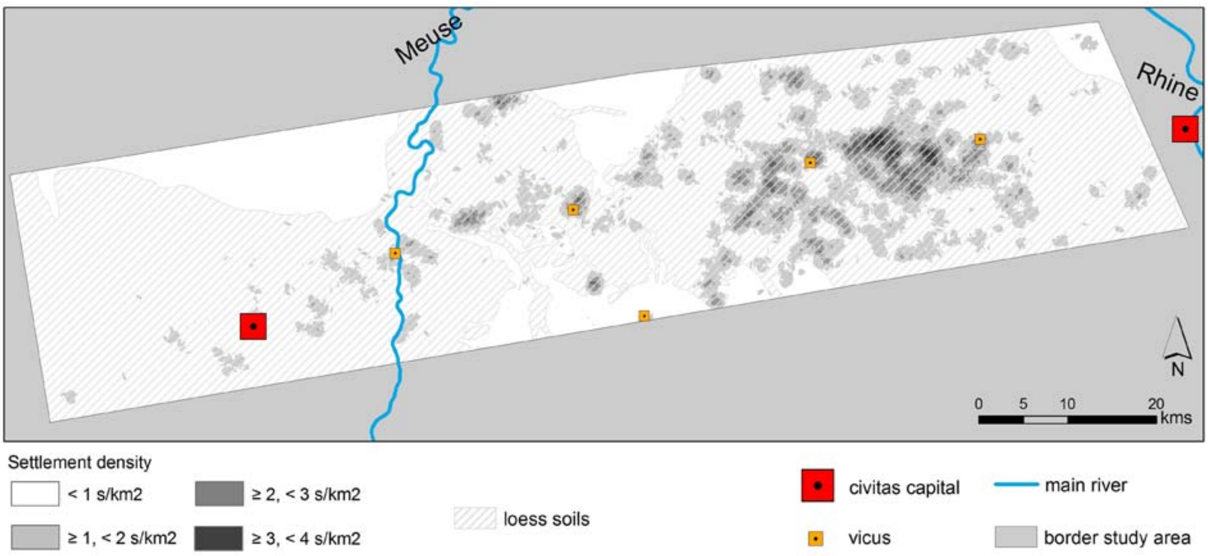


Fig. 5.29 Map showing the location of loess soils in comparison to the settlement density distribution (based on n=1944) within the study area.

[8] See chapter 6 for more information regarding these assumptions.

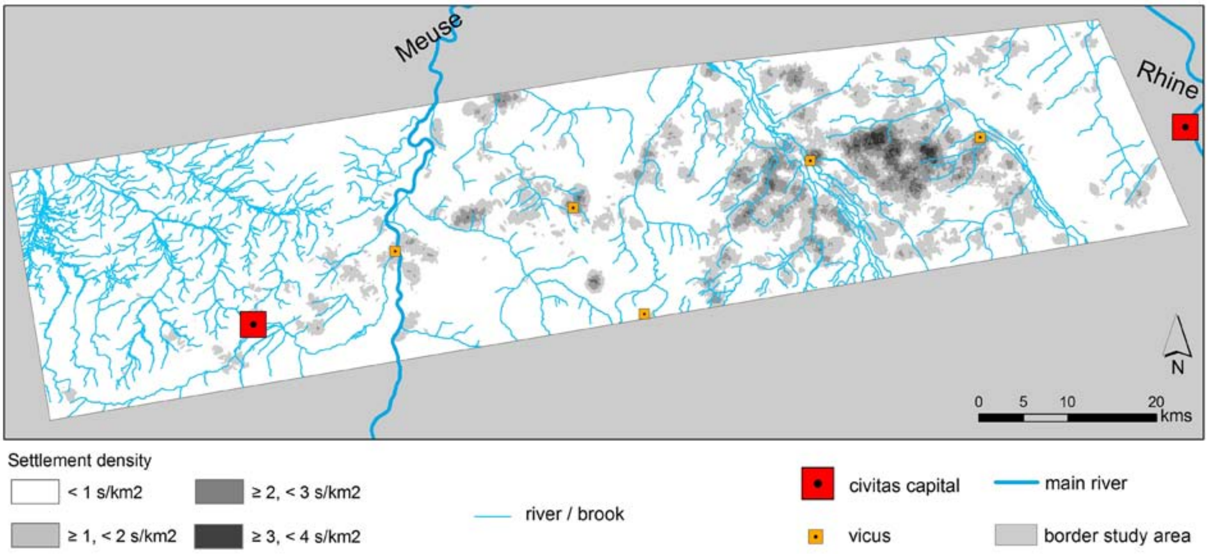


Fig. 5.30 Map showing rivers and brooks in comparison to the settlement density distribution within the study area.

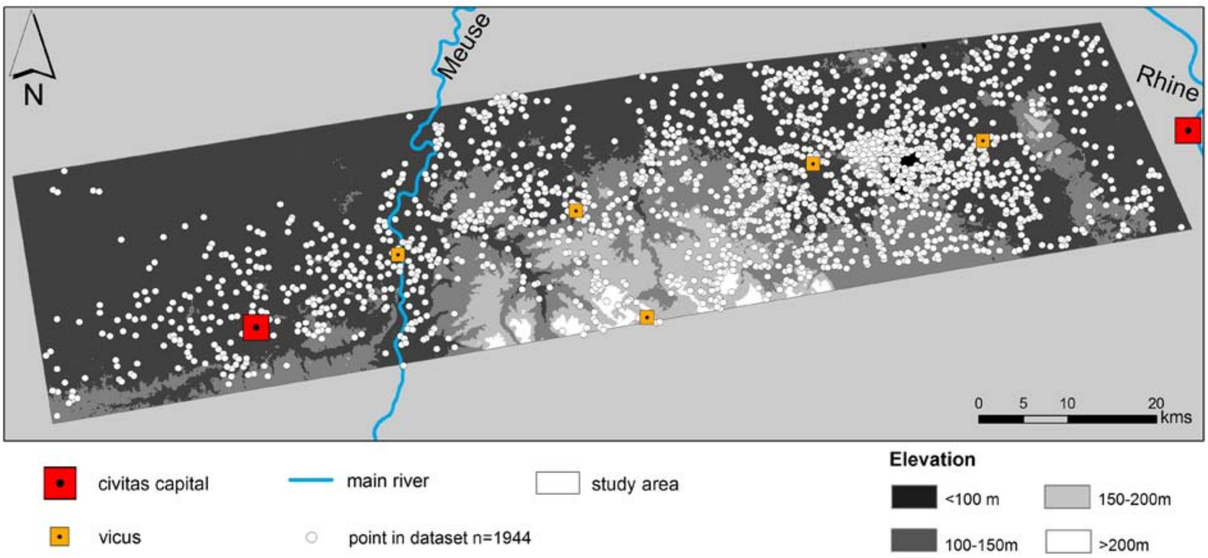


Fig. 5.31 Map showing elevation in comparison to the settlement distribution of dataset n=1944 within the study area.

tant to Roman farmers, and that regions where rivers and streams were sparse were less attractive to settlers, resulting in fewer settlements. However, figure 5.30 shows that in some parts high density is found both in close proximity to water and further away; conversely, low settlement density is found in water-rich areas and in areas where there are hardly any rivers or streams nearby.

The third environmental factor taken into consideration is elevation. Although the maximum elevation in the study area is such that both arable and cattle farming could be practised at virtually any location, figure 5.31 shows that there is no real difference in elevation between areas of higher and lower numbers of settlement.

The last factor taken into account here is the presence of natural stone, a key ingredient in Roman architecture. It could be argued that natural stone deposits at a particular location were responsible for higher settlement numbers. However, the zones with the highest settlement densities in the research

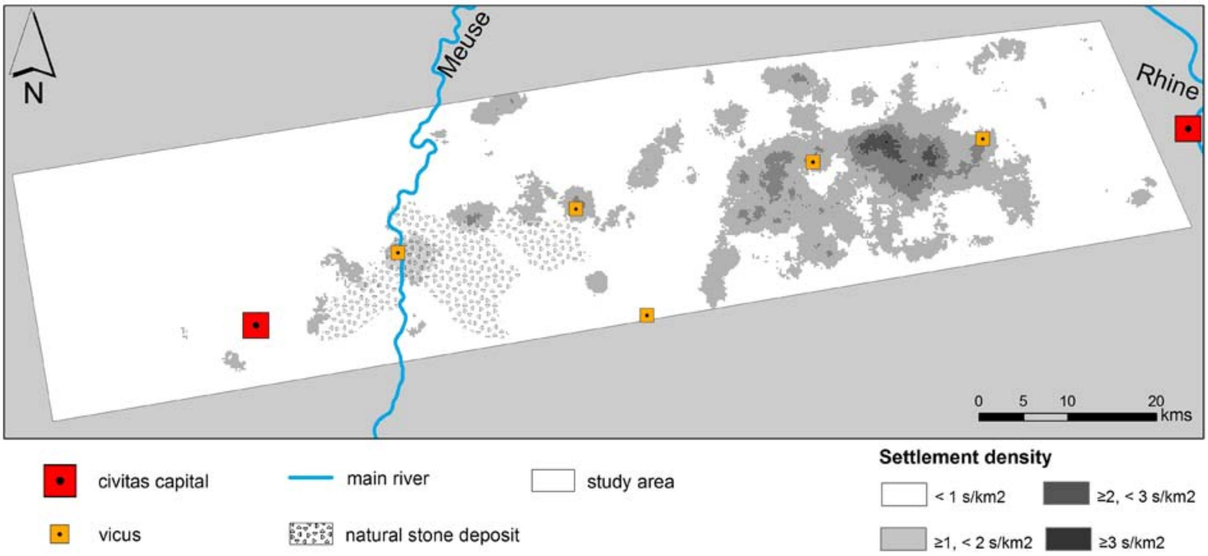


Fig. 5.32 Map showing natural stone deposits in comparison to the settlement density distribution within the study area.

region were actually located far from any such deposits, as shown in figure 5.32. The stone types used in those areas were brought in from other locations, outside the study region.[9] In addition, the presence of limestone and silex deposits in parts of Dutch and Belgian Limburg did not seem to have led to substantially higher settlement numbers.

To conclude, it is not possible to visually identify specific environmental circumstances in the observed area of high settlement density that clearly stand out from the rest of the study region. Perhaps factors of a different nature caused the variation in settlement density.

5.4.2 The socio-economic environment

It is generally accepted that the development of an interregional market was the driving force behind the development in many parts of the Roman provinces.[10] For example, the *limes* located at the river Rhine is usually considered to have been a major stimulus for the development of the countryside in the study area, with the army camps and new towns in this zone functioning as important consumers of agricultural produce. It can therefore be argued that the *limes* zone would have had an impact on settlement, the assumption being that settlement numbers in close proximity to these areas of high demand would be higher. However, the density map shows that this argument does not apply to the study area, as the region closer to the Rhine has in fact lower density numbers than the zones situated further away. Likewise, proximity to a *civitas* capital or any other town, could have influenced settlement patterns, based on the same assumption that proximity to an area of high demand was an important settlement stimulus.[11]

To test this assumption, a zone of 10 Roman *leugae*, or 22 kms, was overlain above the density map. In many parts of the Roman empire, towns were located at approximately 10 *leugae* distance, therefore this is considered as approximately one day's travel for an ox-drawn cart laden with produce.

[9] Rothenhöfer 2005, 106-107.

[10] A wealth of literature exists for this topic; for recent studies see Habermehl 2011, 138; Roymans 2011, 16-19.

[11] For this topic too, a wealth of literature exists; see Roymans 2011, 14-15.

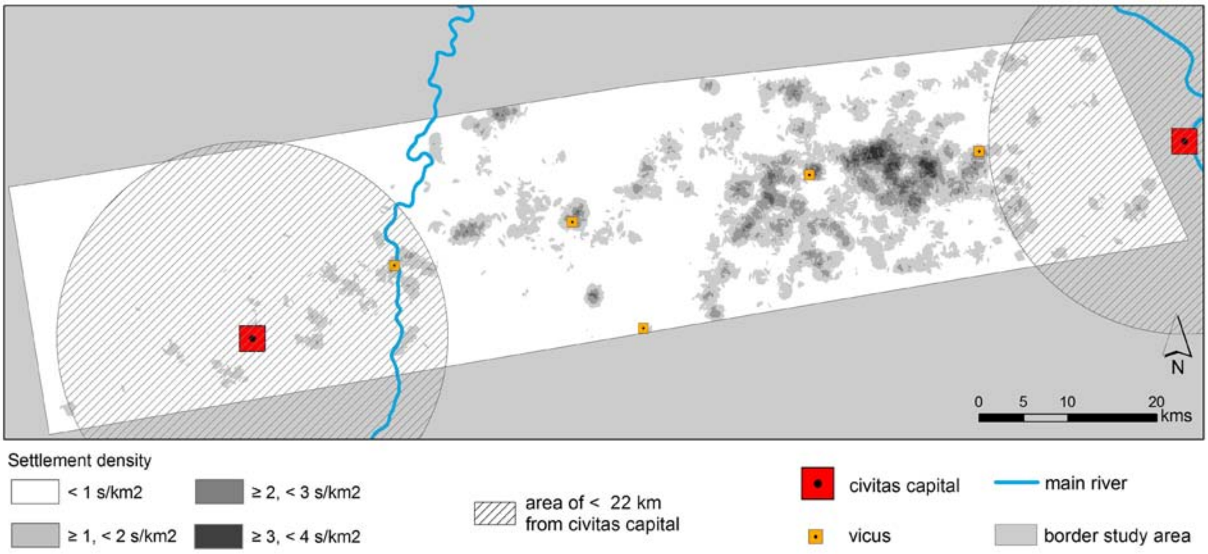


Fig. 5.33 Map showing the zones of approximately 10 Roman *leguae*, or 22 kms, around the two *civitas* capitals of *Colonia Claudia Ara Agrippinensium* (to the right) and *Atuatuca Tungrorum* (on the left), shown in comparison to the settlement density map of the study area.

If proximity to a major town was to have stimulated settlement, it should be expected that the land within this zone would have a significantly higher settlement density. Figure 5.33, however, shows that in fact the reverse seems to have been the case.

Proximity to one of the two main arteries of the region, the rivers Rhine and Meuse, could also be a possible explanation for higher settlement density, based on the assumption that location close to a main artery would be preferable to a location further away.[12] Again, map 5.33 shows that this was not the case in the study area. In fact, the only thing that this map seems to prove, is that in relation to the distance to a major town or river, the areas with the highest settlement densities were found in the most unfavourable location within the study area, at least 30 to 50 kms from the nearest large river, *limes* zone and main town. For a farmer, these distances would have meant at least a day's travel, and more likely two, to the nearest main market or port.

5.4.3 THE INFLUENCE OF ARCHAEOLOGICAL PRACTICES

The evidence presented above seems to indicate that the observed differences in settlement density cannot be easily explained by the presence, absence, or proximity to any environmental factor, whether natural or cultural.[13] Nonetheless, it could still be argued that the observed differences are a reflection of the situation in the Roman period and that there were other variables that influenced settlement yet to be discovered. Before drawing any such conclusion, past and present archaeological activity in each country within the study area must be examined. The most important difference between Belgium and The Netherlands on one hand and Germany on the other, is the large-scale archaeological operations carried out at the heart of the Rhineland in the vicinity of the towns of

12 See Roymans 2011, 17, figure 4 for the importance of the Meuse and Rhine for the supply of the northern *limes*.

13 For the analysis of the perceived influence of more than one factor at the time, see chapter 6.

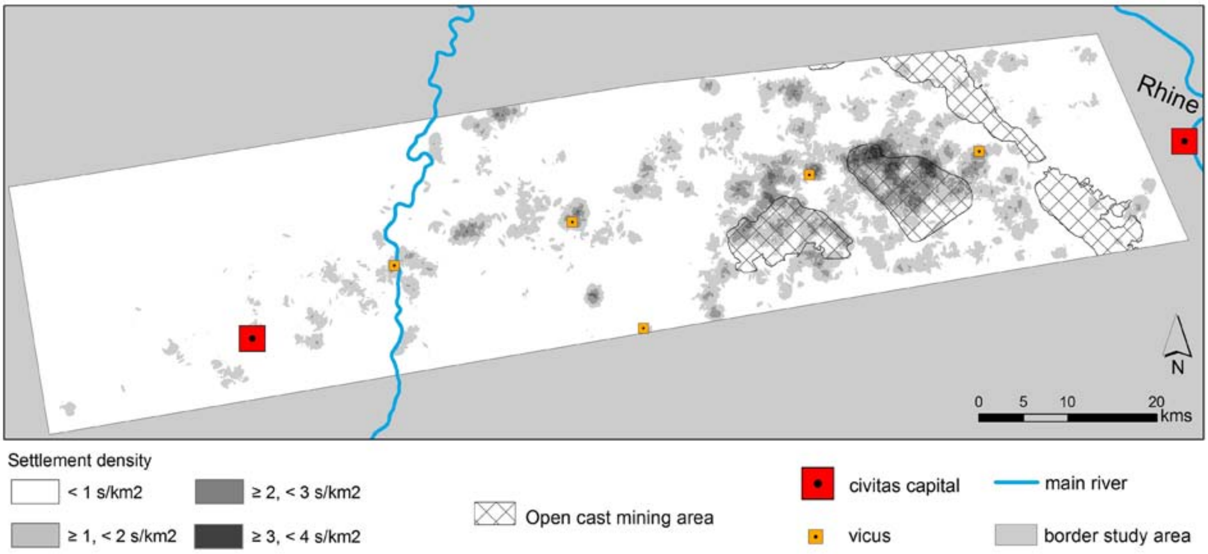


Fig. 5.34 Map showing the location of the lignite mines in the German Rhineland on the settlement density map of the study area.

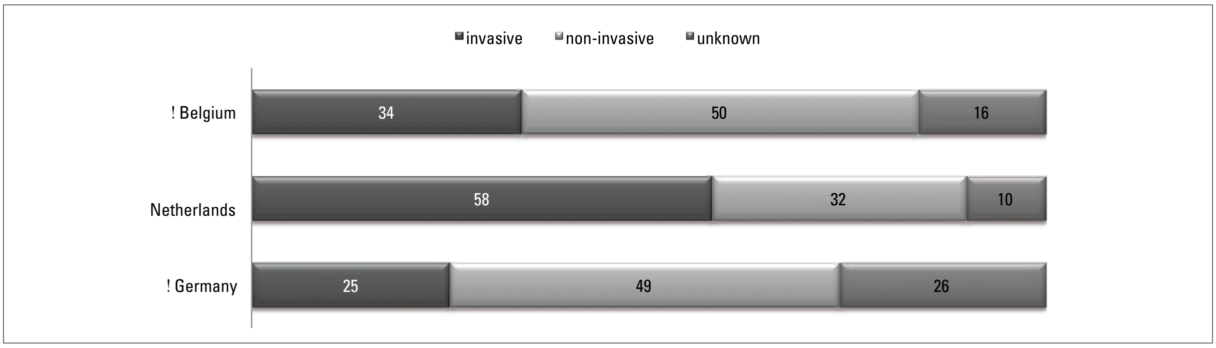


Fig. 5.35 Proportions of research type per country for the overall dataset of the study area.

Jülich and Bergheim. Due to the open-cast mining there, the land within the projected mines has been constantly subjected to the entire range of archaeological activities, from survey to excavation. The land to be destroyed was systematically surveyed several times, under different circumstances. The activities have been carried out by one archaeological institute, and all sites were recorded uniformly within a single database. Archaeological activities in the other two countries have also been connected to building and development projects, but field survey is not as common as in the German region, and the activities are carried out by many different companies.

The archaeological activities in the German mining area means that, here, it is possible to speak of landscape archaeology in the most literal sense, as practically the entire landscape is subject to archaeological examination, before it is destroyed forever. The use of systematic surveys in particular has distinguished this region from the rest of the study area. In fact, the practice of systematic field surveys has not been tied exclusively to the mining areas as, just after WWII, professional and amateur archaeologists carried out large-scale survey projects of the region around Jülich and Bergheim. When the density map is compared to the location of the three main open-cast mines in the Rhineland, the following picture emerges.

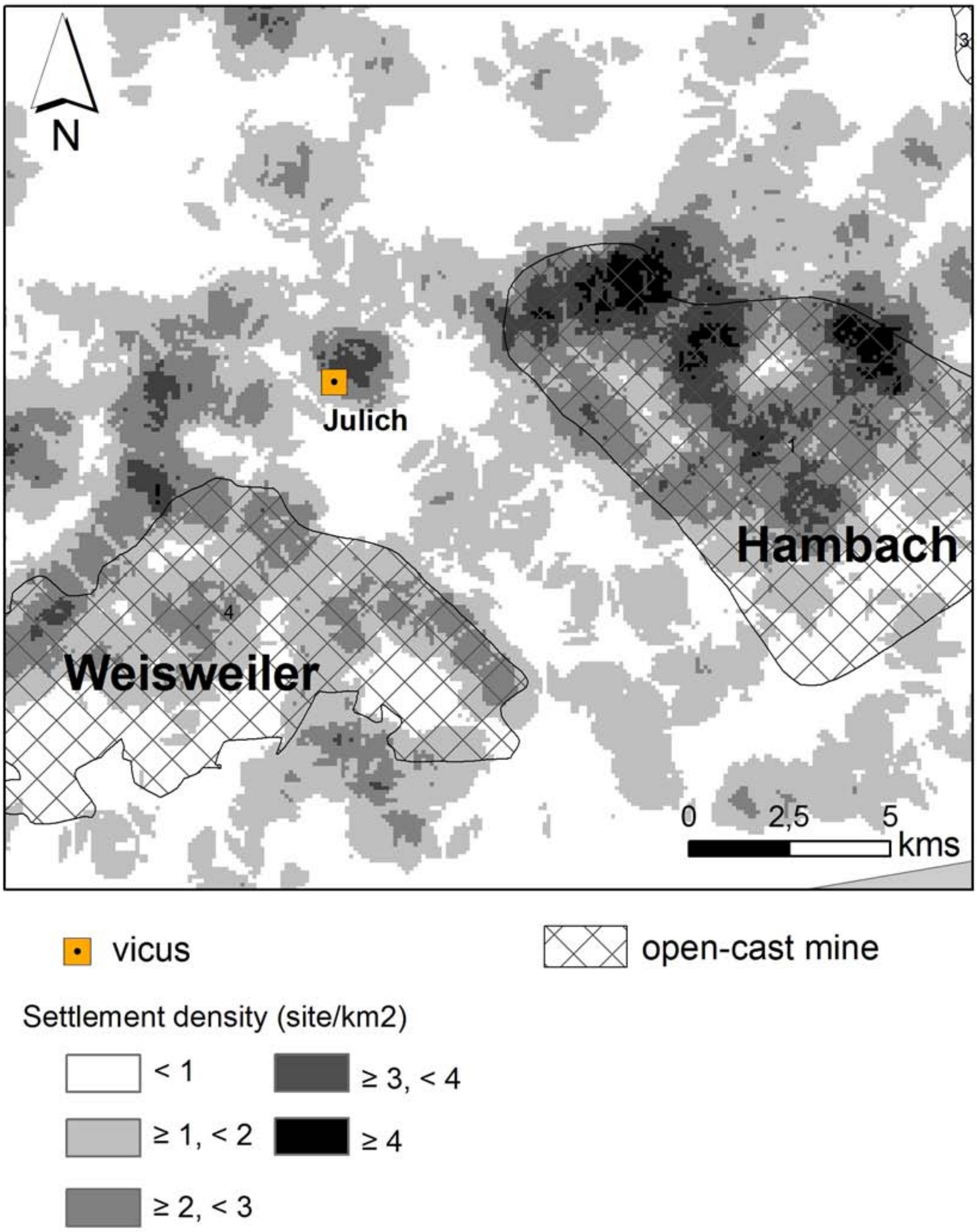


Fig. 5.36 Close up of the settlement density situation in the region around Jülich, with the two open-cast mines of Weisweiler and Hambach.

Figures 5.34 and 5.36 clearly demonstrate that the areas of highest settlement density can be associated with the open-cast mines and the large-scale survey projects carried out in the vicinity of Jülich and Bergheim. In my view this map constitutes conclusive evidence for the argument that the current settlement density maps are the result of a bias created by archaeological activities rather than a reflection of the actual situation 2000 years ago. The areas with the highest settlement density are located where intensive archaeological activities have been carried out, in particular systematic field surveys. Likewise, low(er) settlement density numbers can be related to areas with low(er) intensities of archaeological activities. Whether or not systematic field surveys have been carried out seems to have had a direct effect on settlement density numbers. As a reminder, figure 4.6 from the previous chapter is shown here (figure 5.35). This figure highlights the differences in archaeological practices in the three countries comprising the study area.

Figure 5.34 shows low settlement densities at the two large mines in the east (the Garzweiler-Frimmersdorf mines). This does not undermine the argument, as these mines were exploited much earlier in the 20th century, prior to the era of intensive archaeological prospection. In contrast, settlement densities are highest at the location of the Hambach mine, situated between Jülich and Bergheim. Work here did not start until the late 1970s, and field surveying has been part of the systematic research approach since the beginning.

Differences in past and current land use certainly have had an influence on settlement density numbers, as particular practices enhance the visibility of archaeological remains, while others diminish it; in addition it can be said that in certain circumstances archaeological remains are better protected. For example, in the Weisweiler region, west of Jülich, the land has been farmed and ploughed for hundreds of years. Although archaeological remains are quite easy to detect in such circumstances, centuries of ploughing will have also meant substantial damage to these remains. The Hambach region, east of Jülich, was covered by a large forest for centuries, before the mining activities started. Archaeological remains here did not suffer from agricultural activities the way they did in the Weisweiler region, which could explain why of the two areas, settlement density is highest at Hambach.

An important implication of the above is that the high densities observed in the German lignite mining areas can be regarded as the most reliable reflection of the Roman situation. After all, if the main cause for differences in settlement density amongst micro-regions lies with the archaeological practices, it follows that the density of the region that has been the focus of intensive systematic research should be considered as the most probable scenario. In other words, the average settlement density in the Hambach and Weisweiler region could be applicable to the entire study region. The validity and possible consequences of this observation will now be further explored, using a quantitative approach.

5.5 QUANTIFYING THE SETTLEMENT LANDSCAPE

It has been argued in the previous parts that the average settlement density of the rural landscapes in the study area could have been higher than the current datasets suggests. In order to establish the validity of this claim, the following section will explore several scenarios whereby the settlement density will be used to estimate population numbers. It must be emphasized, though, that it lies outside the scope of this study to construct a thorough analysis of demography, agricultural production and property size. This would constitute an entire study by itself, not least because such calculations are riddled with insecurities and problems. Nevertheless, it was decided that calculating possible numbers based on the evidence presented above could help to assess the validity or impossibility of certain settlement density scenarios, and therefore help to establish which of the scenarios approximates the situation in Roman times. However, it must be reiterated that the following is by no means a conclusive attempt at recreating the demographic situation of the area.

The starting point for such an approach is the settlement density raster datasets. These were created to have cells of 100 by 100 meters, or 1 hectare. The value of each cell corresponds to the average settlement density of that particular area, calculated by performing a Point Density analysis in ArcMap. The values for all cells can be extracted and analysed,[14] and this forms the basis for further calculations.

[14] N.B.: the area of the entire raster used in this calculation measures 3441 km$^{2.}$

Table 5.1, below, shows the average values for the settlement density raster datasets of n=1186 and n=1944, as well as the value ranges of settlement density, together with the number of cells for each of these values. In both cases the average values differ greatly from the 3 to 4 settlements per km^2 that were suggested as a possible scenario for the entire region.

If we know the number of cells, and thus of hectares, and their average settlement density, we can calculate the area for each density value. This value can then be used to calculate the average population per km^2, and, subsequently, we can calculate the overall population number for the entire region by multiplying each value with the corresponding area. To do this the numbers of average population per settlement were needed. For this study, the numbers proposed by Kooistra in her work on Roman farming between the Meuse and Rhine rivers will be used. For the average (stone-built) farm in the German Hambach region, 15 people was seen as a reasonable estimate. The average villa would have been home to three families: the owner and his wife and children, together with two labours and their families.[15] For a larger rural settlement, such as the one at Voerendaal – Ten Hove, an average of 50 people was used. It was estimated that 10 families lived on a large villa: that of the owner/administrator, of the foreman, and of eight labourers.[16] In this study, a lower number of eight people per settlement was added, based on work by Goodchild who estimated that the average family on a small farm on the Italian peninsula during the Early Imperial period would have consisted of two adults, three

	DATASET N=1186	**DATASET N=1944**
value range	**no. of cells (ha) per value**	
0	1722515	128141
0.3	74330	68196
0.6	44787	51959
0.9	24660	35026
1.3	14844	24032
1.6	7751	14962
1.9	3730	8564
2.2	1275	5474
2.6	395	3248
2.9	130	1930
3.2	7	1123
3.5	1	610
3.8	-	417
4.1	-	259
4.5	-	124
4.8	-	57
5.1	-	3
minimum value	0	3.5
maximum value	0	5.1
average value settl./km^2	0.33	0.55

Tab. 5.1 Overview of the range, minimum, maximum and average values for the settlement density of each of the two datasets used in this study.

15 Kooistra 1996, 98. The values were based on Gaitzsch 1986.

16 Kooistra 1996, 109.

children and one elderly dependent.[17] This makes three scenarios for the population of a single rural settlement: a small farm with 1 family, a medium-sized farm with three families, and a large farm with 10 families. For each of these estimates the corresponding values for the average number of settlements per km² could be calculated, as shown in table 5.2, below.

Combining the information in tables 5.1 and 5.2, a total estimate of population for the study area could be calculated, based on the different scenarios. The number of cells per settlement density value was recalculated to reflect the total number per km², by dividing the number of cells by 100. The resulting value was then multiplied with the corresponding value for the number of people per km². When all of these values were added up, the total number of people for the entire study area was calculated, based on each specific scenario of number of people per settlement. This was done for the settlement datasets n=1186 and n=1944. The results are shown in table 5.3 and 5.4.

	corresponding value people / km²	**corresponding value people / km²**	**corresponding value people / km²**
value range settlement / km²	**Farm – 1 family population = 8 / settlement**	**Farm – 3 families population = 15 / settlement**	**Farm – 10 families population = 50 / settlement**
0	0	0	0
0.3	2.4	4.5	15
0.6	4.8	9.0	30
0.9	7.2	13.5	45
1.3	10.4	19.5	65
1.6	12.8	24.0	80
1.9	15.2	28.5	95
2.2	17.6	33.0	110
2.6	20.8	39.0	130
2.9	23.2	43.5	145
3.2	25.6	48.0	160
3.5	28.0	52.5	175
3.8	30.4	57.0	190
4.1	32.8	61.5	205
4.5	36.0	67.5	225
4.8	38.4	72.0	240
5.1	40.8	76.5	255

Tab. 5.2 Conversion of number of settlement / km² into number of population / km², based on three different scenarios for the average population of a rural settlement.

[17] Goodchild 2007, 333.

settlement density value	no. of km² per value	people / km² population = 8 / settlement	people / km² population = 15 / settlement	people / km² population = 50 / settlement
0	17,225.15	0	0	0
0.3	743.30	1,784	3,345	11,150
0.6	447.87	2,150	4,031	13,436
0.9	246.60	1,776	3,329	11,097
1.3	148.44	1,544	2,895	9,649
1.6	77.51	992	1,860	6,201
1.9	37.30	567	1,063	3,544
2.2	12.75	224	421	1,403
2.6	3.95	82	154	514
2.9	1.30	30	57	189
3.2	0.07	2	3	11
3.5	0.01	0	1	2
TOTAL	3,441.25	9,151	17,158	57,193
AVERAGE	-	3 P/KM²	5 P/KM²	17 P/KM²

Tab. 5.3 Calculation of the population in the study area, using n=1186, for three population scenarios.

Table 5.3 shows the results of the scenarios for the dataset n=1186. If it is assumed that the average Roman rural settlement was inhabited by 8 people (three generations, so including elders and children) the total population number of the study area would have been less than 10,000. This on average means a population density of 3 people per km². If the scenario of 15 people per settlement is used, the total population number increases to just over 17,000 people, with an average of 5 people per km². The most generous scenario of 50 people per settlement results in a total population of just over 57,000, with an average of 17 people per km². The next table presents the calculation based on the dataset n=1944.

Using the dataset n=1944, the total population of the rural landscape would have been just over 15,000 people if all settlements were populated by a single family. In the second scenario this number is approximately 28,000 and in the 50 people per settlement scenario this is nearly 94,000. The average number of people per km² are 4, 8 and 26 according to the three scenarios.

In order to appreciate these different scenarios, information is needed on what is commonly held to be a reasonable population size in the Roman provinces. Although quantitative studies on population size are rifled with insecurities, several scholars have recently attempted to calculate regional demographies. Witcher investigated the population size of the *suburbium* of Rome.[18] He differentiated between the population of a farm (5 – 15 people) and that of a villa (15 – 50 people). He arrived at a range of between 35 and 119 people per km², and proposing 60 people per km² as an informed estimate. It has to be pointed out that Witcher's study area counted as one of the most densely populated area in the Roman empire, and included both rural countryside and towns. He therefore added that 32% of the population would have been living in towns, and 68% in the countryside.

18 Kay / Witcher 2005, 126-128.

settlement density value	no. of km² per value	people / km² population = 8 / settlement	people / km² population = 15 / settlement	people / km² population = 50 / settlement
0	1281.41	0	0	0
0.3	681.96	1637	3069	10229
0.6	519.59	2494	4676	15588
0.9	320.26	2522	4729	14412
1.3	240.32	2499	2918	15621
1.6	149.62	1915	3591	11970
1.9	85.64	1302	2441	8136
2.2	54.74	963	1806	6021
2.6	32.48	676	1267	4222
2.9	19.30	448	840	2799
3.2	11.23	287	539	1797
3.5	6.10	171	320	1068
3.8	4.17	127	238	792
4.1	2.59	85	159	531
4.5	1.24	45	84	279
4.8	0.57	22	41	137
5.1	0.03	1	2	8
TOTAL	3,441.25	15,193	28,082	93,608
AVERAGE	-	4 P/KM²	8 P/KM²	26 P/KM²

Tab. 5.4 Calculation of the population in the study study area, using n=1944, for 3 scenarios.

Goodchild reconstructed demographic numbers for the Roman landscapes of the Middle Tiber valley in Italy.[19] She used static households for farm and villa settlements: a total number of 6 people was assumed (two adults, three children, one elderly dependent) for a farm, and 25 for a villa (workforce, household staff and resident elite). For different parts of her study area, she estimated averages of 10 and 41 people per km² for the Early Imperial period.

For the German Rhineland, Wendt and Zimmermann use a range of 10 to 20 people per villa settlement, with a maximum of 30.[20] They also used estimates of average numbers of villa per km², ranging from 1,2 for the Aldenhovener Platte and 0,8 for the Hambach region.[21] Consequently, their numbers resulted in an average population number of 8 to 24 per km² for the region around Jülich, with a maximum of 36.

19 Goodchild 2007, 332-335.

20 Wendt / Zimmermann 2008, 196-226.

21 Note that Wendt / Zimmermann 2008 used the basic ABR dataset for their calculations, which in this study corresponds roughly to the n=1186 dataset. This explains the lower settlement per km² number used in their study.

People / km²	Witcher, *suburbium* Rome	Goodchild, Tiber valley	Wendt & Zimmermann, Jülich region
low estimate	35	10	8
high estimate	119	41	36
average estimate	60	25	16

Tab. 5.5 Minimum, maximum and average values for the number of people per km² as calculated for different regions by particular scholars.

Comparing the numbers by the different researchers with the averages obtained from the datasets n=1186 and n=1944, it can be said that the averages based on n=1186 are on the low side, even if the high estimate of 10 families / 50 people per settlement is used. The averages based on n=1944 seem to be more in line with the averages calculated by Wendt and Zimmermann; however, compared to the averages calculated by Goodchild, they still seem to be on the low side. This is an important observation, as the region studied by Goodchild consisted of a mix of smaller and larger rural settlements, which in my opinion matches the situation in the study area at hand better than a scenario in which the landscape consisted solely of large estates. For this I refer back to chapter 3, where the variety amongst the stone-built rural settlements was already demonstrated.

	Population scenarios		
	1 family	3 families	10 families
N=1186	3 P/KM²	5 P/KM²	17 P/KM²
N=1944	4 P/KM²	8 P/KM²	26 P/KM²

Tab. 5.6 Average values of population per km², for the two settlement datasets and according to the three population scenarios.

Based on the above, I would suggest that the n=1944 dataset is not improbable; in fact I would like to propose that the n=1944 dataset is a more realistic scenario than the n=1186 dataset. The different population scenarios per settlement, however, elucidated the necessity to further elaborate on the composition of the rural settlement landscape with regards to the settlement types. This will be addressed next, but first the validity of the indicated possible settlement density of more than two settlements per km² will be discussed.

Earlier it was suggested that the settlement density of 3 to 4 settlement per km² established for the region surrounding Jülich (using the n=1944 dataset) could represent the actual settlement density situation for the entire study area. To find out if this claim holds any validity, it is important to calculate the consequences of that scenario. Using the three different population scenarios per settlement introduced earlier, the total and average values can be calculated for different settlement densities. This is shown in table 5.7.

	1 settlement / km²	2 settlements / km²	3 settlements / km²	4 settlements / km²
8 people / settlement	27,528	55,056	82,584	110,112
	8	16	24	32
15 people / settlement	51,615	103,230	154,845	206,460
	15	30	45	60
50 people / settlement	172,050	344,100	516,150	688,200
	50	100	150	200

Tab. 5.7 Calculation of the maximum population for the study area (3,441 km²) per population scenario and per settlement density scenario. The value in white is the total population number; the value in grey indicates the average population number per km².

What is interesting is that the figures for the 3 settlements per km² match the averages proposed by Goodchild (average of 25, maximum of 40). This is important because in Goodchild's study, the rural landscape in the Tiber valley was reconstructed with two types of rural settlements, villas and farms, in preference to a single type of settlement. Her population averages were thus based on a rural landscape composed of different types of settlement. Obviously the natural environment of the Tiber valley differs greatly from that of the study area. However, this could be seen as an argument in favor of higher settlement densities in the loess region, as it could be claimed that it was much more suitable for arable farming than the landscape of the Tiber valley. It would be interesting to see whether it is possible to reconstruct a landscape consisting of small (8 p/settlement), medium (15 p/settlement) and large (50 p/settlement) settlements, whereby the small settlements correspond to post-built settlements, and the medium and large to stone-built types. The difference between the medium and large settlements would be the variety, observed in chapter 3, in house size and architectural elements associated with a luxurious lifestyle such as a hypocaust and private baths.

Based on the proportions of stone-built to post-built settlements observed earlier, a scenario was made with 3 settlements per km²: 1 post-built and 2 medium-sized stone-built. Based on this composition, the average population per km² would be 38. Whether or not this was a viable reconstruction depends on another factor not yet discussed: the size of the plot of land per settlement. Again Goodchild has thoroughly explored this issue, using not only results of archaeological activities, but, importantly, a range of historical sources. These sources provided important information, regarding, for example, the minimum plot size for a self-sufficient farming family, or regarding the number of labourers needed annually for a particular plot size to perform the most important farming tasks, such as ploughing and harvesting. This touches upon an issue that is seldom addressed in studies regarding the rural landscapes between Meuse and Rhine, which is whether the assumed plot size of an average villa was actually manageable with the available labour force estimated to have worked at that villa. Often when numbers for settlement density are provided, references to the management of the land, the necessary labour force are lacking. I would suggest that these are important issues that need to be taken into account; with regards to the study area at hand this could mean that the landscape was more densely populated than is generally thought. This can be illustrated using the following example. In the 1 settlement per km² scenario, a settlement has 100 hectares of land.[22] The question is whether this one settlement provided the necessary labour to manage the estate. As established in chapter 3 using house sizes and specific architectural elements, large stone-built settlements, which, potentially,

[22] It is assumed that the land in the study area was completely divided amongst the settlements, in other words that no land was left 'untouched'. It is expected, however, that not all land was used for crop growing.

could have had up to 50 people on the premises, formed a minority in the study area at 10 to 15%. The medium-sized stone-built farm, estimated to house 3 families, can therefore be assumed to have been the more regular settlement. It has already been pointed out that these three families delivered a workforce of three men. Is it realistic to assume that these 3 labourers could have successfully managed the 100 hectare estate that follows from the 1 settlement / km^2 density?

According to Roman sources, one labourer was needed for every 33 *iugera* / 8 hectares of land.[23] This means that 100 hectares would have required 12 labourers. Of course it could be argued that not all of these 100 hectares were under cultivation each year. Supposing that only 50% was under cultivation yearly, 6 labourers were required following the 1 labourer per 8 hectares of land guideline. As it was assumed that a medium-sized stone-built farm housed 3 families, this means that 3 extra labourers were necessary on a permanent basis. Where were these families living, if not on the farm itself? Additionally, during ploughing time and harvest, substantially more labour was needed, as the time span for these labour-intensive activities is short. Where did this extra labour come from? Where were they living the rest of the year? I would like to suggest a scenario that provides the answers to these questions. The starting point of this scenario is the settlement density suggested earlier of 4 settlements per km^2, and a key element is its composition of different types of farms. It is suggested that of the 4 settlements, 2 were medium-sized stone-built farms, each housing three families. In addition, there were 2 small, post-built farms, each housing one family. According to the Romans, a plot of 2 to 5 hectares was the absolute minimum to support a family on a subsistence basis.[24] If the small farms each had 5 hectares for self-subsistence, this would leave 90 hectares for the two medium-sized stone-built settlements, meaning 45 hectares per settlement. If this land was farmed using a crop-rotation scheme, it would be possible to grow crops on 30 hectares each year, leaving 1/3 fallow. For these 30 hectares, 4 labourers would be needed on a permanent basis; 3 of these could live on the villa itself, with the fourth labourer living with his family on the small-holding. This scenario would mean a total of eight families on every 100 hectares/km^2. This scenario does not, however, solve the problem of the additional labour needed during ploughing time and harvest. Perhaps the newly-identified 'concentrations of habitation' in the region and higher number of small roadside villages played a role here. It could be argued that craftsmen, living in a village setting for most of the year, worked on the land during ploughing time and harvest, this way securing an extra income. The location of at least three of the 'concentrations of habitation' away from the main road could be proof for the validity of this assumption.

Needless to say, further research into the composition of the landscape is needed before any of these questions can be answered. Also, the subjects of property size and labour force are much more complicated than the scenario above suggests. Temporal dynamics have to be taken into account too, after all, the Roman landscapes in the study area developed over a period of more than three centuries. It is important, therefore, to reiterate that the above was not meant to solve the issue of settlement density and population numbers. Nonetheless, it was deliberately presented in order to prove that it is possible to come up with scenarios that fit the higher settlement density pattern suggested by the dataset n=1944. It is hoped that this line of inquiry will be the subject of future research.

23 Goodchild 2007, 80, cf. Columella (Rust.2.12.1-6)

24 Goodchild 2007, 84, cf. White 1970.

5.6 STONE OR TIMBER?

The previous section served to demonstrate that in order to really understand the social structure of the rural landscapes and the working of the agricultural economy, it is vital to fully reconstruct the rural settlement landscape. If an entire layer of this landscape is missing, it is impossible not only to reconstruct the demographic situation, but also to build social and economic models that reflect the original situation. It is difficult to examine the social hierarchy of the rural population in a region if there is information only about the settlements of part of that population. Therefore, the discussion regarding the proportions of post-built versus stone-built settlements is brought up once more.

In view of the earlier argument that archaeological practices, rather than the original Roman situation, were responsible for the observed differences in settlement density in the study area, the next obvious question to answer is whether archaeological practices were responsible for the current views on the composition of the settlement landscape. This is an issue which has already been addressed by many scholars, in particular those working in the Mediterranean area, where systematic field survey results are often the only datasets available, including 'legacy data'.[25] Studies have indicated that the high visibility of remains of stone-built structures, either buried or scattered on the surface, inevitably results in a bias towards this type of settlement, and therefore an underestimation of smaller, post-built sites, where significantly fewer durable materials were present to start with. The differences in the find assemblages of the two main types of settlement means that the results are often biased in favor of stone-built sites, even when systematic field surveys were an important part of the archaeological practice. This bias also has another consequence. Past practices influence where new investigations are carried out, for example when archaeological results are used to make predictive models. These models are used by archaeologists to determine where new research is to be carried out, and more importantly, where not. It can be argued that in The Netherlands, where excavations are the main archaeological activity, focus on stone-built sites in the past has resulted in a situation whereby post-built Roman settlements in Limburg are virtually unknown. Therefore, no one seems to expect this type of settlement in South Limburg, and not surprisingly they are never found.[26] In fact, the only reason why a complete post-built rural settlement was excavated in Limburg in 2009 (the first Roman post-built settlement in South Limburg ever to be completely excavated!) was because roof tile fragments had been found on the surface of the site, and it was therefore registered as a villa site in the national archaeological database Archis. It is not too far-fetched to conclude that because of all this, it is nearly impossible to evaluate or alter this perception of a landscape completely dominated by stone-built settlements.

Although it lies beyond the scope of this study to explore the issue more thoroughly, I suggest that the settlement landscape in figure 5.37 west of *Tiberiacum* shows a scenario of post-built settlements scattered amongst the stone-built settlements can already be identified in the study area, based on the re-interpretation of burial and indefinable evidence. Self-sufficiency is assumed for the small farms for most of the year; their owners could have worked on the fields of the stone-built settlements during harvest and ploughing season, as was discussed earlier. It should come as no surprise that the landscape shown in figure 5.37 is located within the area of the Hambach lignite mine. Here, many sites consisting of little more than a few pottery fragments have been detected by means of repeated surveying. It can be argued that they represent small settlements consisting of a single post-built dwelling, housing a single family. Unfortunately sites like these are rarely excavated, making it difficult to substantiate this claim. However, in other similar regions, scholars suggest that the current views regarding the proportions of stone-built to post-built rural settlements are in need of adjustment, and it is hoped that future fieldwork will address this issue.[27]

[25] See for example Witcher 2008, and Goodchild 2007 chapter 3.

[26] This seems to be a self-perpetuating situation, along the lines of 'you will never find what you do not look for'.

[27] Cf. The discussion in Ouzoulias 2006, 147-150, for the north of France.

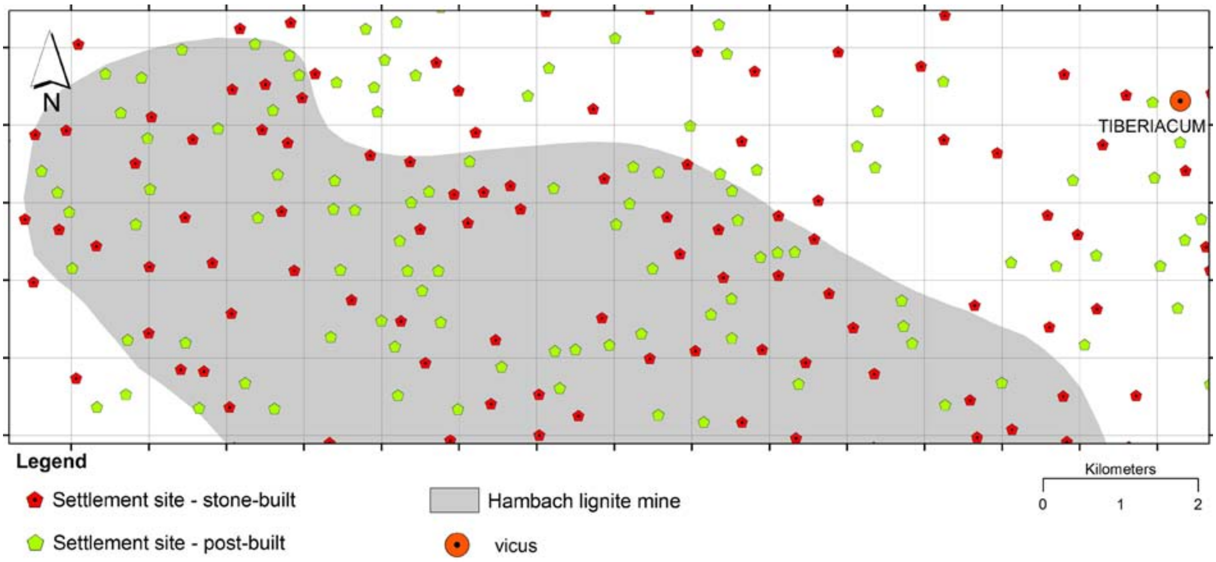


Fig. 5.37 Map of the reconstructed landscape west of the *Tiberiacum*, based on the dataset n=1944. It shows that the proportion of stone-built to post-built settlements is approximately 1:1.

5.7 FINAL OBSERVATIONS

This chapter presented the process of a settlement landscape reconstruction, based on the assumption that certain types of evidence, such as burials and single finds, represent settlements, under the condition that they comply with the spatial criteria established for the average rural settlement in the region. The reappraisal of three categories of data resulted in two new settlement datasets, n=1186 and n=1944.

These were then used to produce settlement density maps that were subsequently investigated. It was found that, rather than environmental factors, biases created by differing archaeological practices of the three countries in the study area were responsible for the observed differences in settlement density; whether or not field surveys were systematically carried out seemed to be a decisive factor. The traditional focus on stone-built structures in the region has meant that post-built settlements have been almost literally overlooked, as though they were absent from these landscapes, a view that is challenged by the new reconstruction.

The final part of this chapter explored the possible consequences of the higher numbers of settlement observed. A first attempt at quantifying the population of the rural landscapes showed that it is possible to reconstruct a scenario of four settlements per km^2, two of which were stone-built and two post-built.

The final chapter of this study will continue the exploration of the environment of the settlements, using the two new settlement datasets presented above.

6. Settlements and their environment

After attempting to reconstruct the Roman settlement landscape, an examination is now made of the settlement pattern in relation to the environment. The aim of the following chapter is to explore potential preferences in settlement behaviour in the study area.

The process of analysing past landscapes and their relations to the environment are not without their problems, as pointed out by a large number of scholars over the years.[1] Not only are the techniques themselves subject to criticism. Choosing which factors or variables to test is problematic in itself. Some scholars mainly use factors from the physical environment. De Laet, for example, used altitude, slope, aspect, distance to main and affluent rivers, distance to springs, distance to natural corridors, solar insulation, geomorphology, lithology and visibility for the creation of a settlement location model for the Sagalassos area in Turkey.[2] Others combine environmental and social elements. Goodchild, for example, used distance to Roman roads, distance to towns and nucleated centres in addition to altitude, slope, aspect, soils, geology, land use, woodland areas, river systems and geomorphology for the Roman settlement evidence of the Middle Tiber Valley in Italy.[3] Analysis of the dataset for the study region of this thesis showed that it was very much an agricultural society. It was therefore assumed that soil type, distance to open water, altitude, slope and aspect influenced settlement patterns.[4] Roman historical sources back this assumption. A well-known source for Roman farming practices is Cato, who, in his *De Agricultura,* identified factors deemed important to farmers of that time.[5] He provided a detailed description of the elements to be taken into account when choosing the location for a farm. Although the work is obviously directed at farmers in the Mediterranean area this information is considered a good reflection of the way in which farmers at that time looked at their environment and which elements were perceived as being crucial to the success of a farm. Following Cato's advice, a good location for a farm was defined by the following elements: at the foot of a mountain, south facing, a healthful place, a good supply of labourers, well-watered, and near a good town, sea, navigable stream or a good and much-travelled road.[6] Although 'a healthful place' might be difficult to identify in the physical environment, all other elements can be translated to the situation in the study area, such as loess soils, land at a particular elevation, south facing slopes, near a supply of open water, near a town, near a main road and/or a navigable river. Because of this, and because of the availability of this environmental information for the study area, these variables will be tested.

In the following pages soil type, distance to open water, altitude, slope and aspect, as well as distance to a main town and distance to a main road will be analysed for their possible influence on Roman settlement in the study area. Following the results of the previous chapter, two settlement datasets will be

1 The literature on this topic is extensive. Both Verhagen 2007 and Van Leusen 2002 contain reviews of methods and their associated problems, amongst many others.

2 De Laet 2007, chapter 1.

3 Goodchild 2007, chapter 4.

4 Even though in chapter 5 it was concluded that the bias caused by differences in archaeological practices, rather than natural factors was the main reason for the observed variety in settlement density, it was decided to perform spatial analyses for a wide range of the environmental factors, in order to statistically determine the perceived influences and to rule out any insecurities caused by the 'palimpsest' overlay method used in that chapter.

5 Cato, De Agricultura.

6 Cato, De Agricultura, I.3-4.

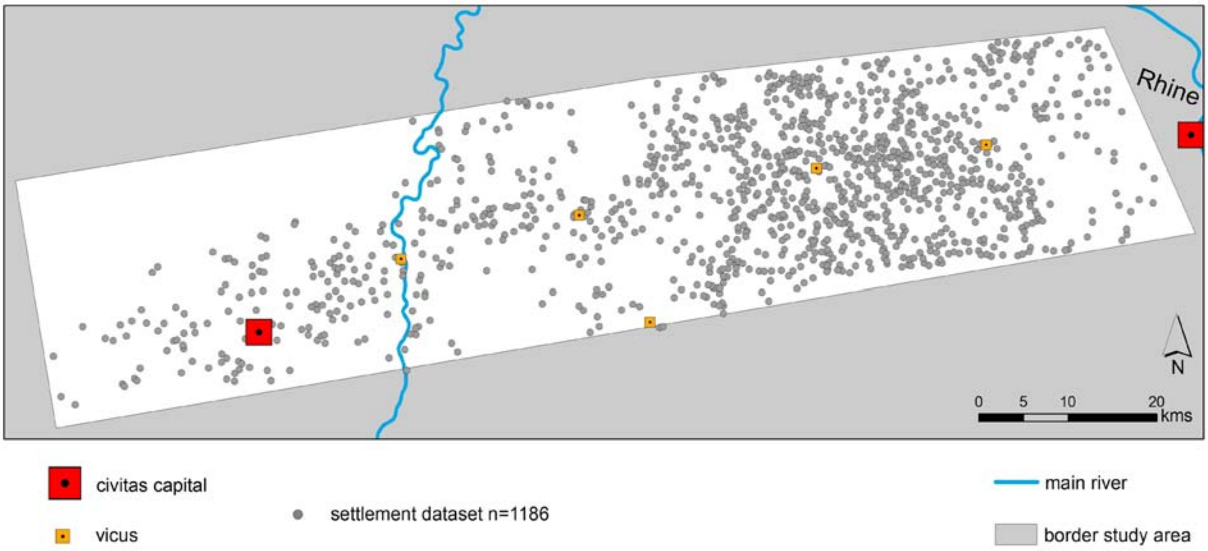


Fig. 6.1 Distribution of the settlements of the dataset n=1186.

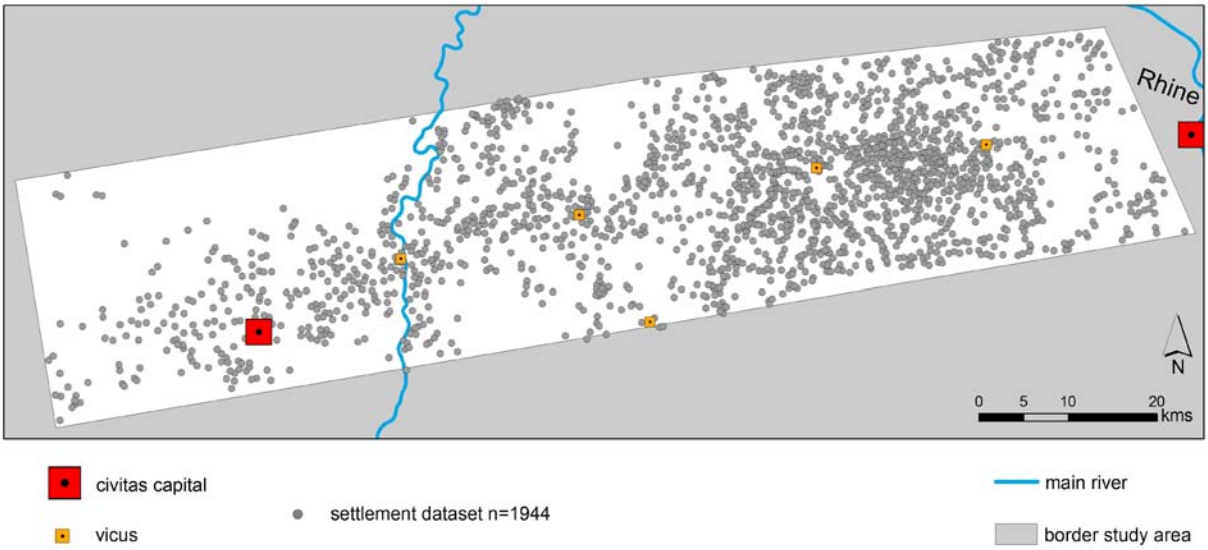


Fig. 6.2 Distribution of the settlements of the dataset n=1944.

used; the revised settlement dataset n=1186, and the reconstructed dataset that includes non-settlement evidence, n=1944. Figures 6.1 and 6.2 show the distribution of both datasets. Each variable will be tested for, not only both settlement datasets, but also for the two types of settlement, stone-built and post-built which is especially important when trying to establish possible differences in location preferences between them. Because it could be argued that the n=1944 settlement dataset is not sufficiently reliable, due to its more experimental nature, the analyses will be performed on both datasets.

Before such analyses take place, however, the concept of 'choosing a place to live' must be discussed. The underlying assumption regarding locational analysis is that people played an active role in choosing the location of their home, but to what degree were people free to make this choice? In a society where land was owned by family groups, the choice of 'where to live' was not determined by any environmental factor, but rather by membership of a particular family. Obviously in the case of new settlers this can change, although in that scenario, social status and/or personal wealth might be more influential than environmental factors. In the study area, the issue of continuity/discontinuity of habitation from late La Tène to the early Roman period would certainly have influenced settlement choice. In case of a continuation of population it can be argued that the native population would be more or less tied to their land and therefore had no active choice in the location of their settlement; a discontinuity however would mean a break with the La Tène property situation and this could in turn mean a '*tabula rasa'* for newcomers to the area, who would then arguably choose a location based on environmental factors. As noted earlier, sufficient reliable information regarding the continuity of habitation of the region during this period is sadly lacking. However, if the original inhabitants really were annihilated by Julius Caesar, and new tribes were brought in from across the Rhine, can it be said that this would result in a completely new settlement pattern, based predominantly on environmental factors? Also, what about the role of Rome? Did Imperial authorities determine where settlers could make their home? Did it matter whether newcomers were civilians from neighbouring regions, or military veterans? The personal status and wealth of an individual could also arguably influence whether they had a choice regarding the location of their new dwelling or not. The above demonstrates the difficulties of the issue at hand. It is important to keep this in mind when interpreting the results of the analyses in this chapter, especially when addressing the perceived differences in 'settlement behaviour' between the two different types of rural settlements. Even with the unresolved problems outlined above, the results of the locational analyses in this chapter are not without value, as they will at least allow for an informed decision of whether specific areas of the landscape were statistically more densely populated than expected, thereby testing some of the common assumptions regarding the location of Roman rural settlements in the region.

The Chi-squared test

To establish whether variables are associated, the standard Chi-squared test is used.[7] With this method it can be statistically established whether two variables are associated, for example, settlement and soil type. If Roman farmers actively sought out the loess soils, it is expected that significantly more settlements were located on these soils than on other types. First it must be calculated how much of the entire region consists of the preferred soil type. These proportions are then used to calculate how many settlements (of the entire settlement dataset) are expected to have been located on the loess soils if soil type did not matter to farmers, in other words, if no relation existed between settlement and soil type. This is the expected cell frequency. Next the actual number of settlements located on this soil type is counted, together with the number of settlements on all of the other soil types.[8] This is the observed cell frequency. The results are in the form of a contingency table.[9] With these values the Chi-squared test statistic can be established for each of the cells of the contingency table, using the Chi-squared formula:

$$\chi 2 = \sum \frac{(O-E)^2}{E} \qquad \text{where} \quad E = \text{expected cell frequencies if } H_0 \text{ is true}, \quad O = \text{observed cell frequencies}$$

The null-hypothesis, or H_O , is always 'the two variables are NOT related'. Therefore, if the observed value is the same as the critical value or higher, the H_O is rejected and the alternative hypothesis, H_A, is accepted; H_A being 'the two variables ARE related'. In our example, if it is found that there are significantly more settlements on the loess soils than expected, and significantly less settlements on

7 Fletcher / Lock 2005, chapter 11 was used as a guideline for the method used in this chapter.

8 To obtain the different environmental values per settlement, the 'Extract-value-to-point' spatial analysis tool was used in ArcMap 9.3.

9 In this study calculations were performed using XL-STAT.

the other soil types, the chance of settlement and soil type being related is statistically such that it can be considered as true. The 'critical value' is related to a percentage point, which indicates the chance, expressed in a percentage, of rejecting the original hypothesis (H_O), whilst it is true. The lower the percentage point, the higher the certainty that the observed (in) dependence of the two variables is true.[10]

It must be emphasized, though, that the results of the Chi-squared test has been criticised in the past, as the results cannot be used as an indication for the relative importance of individual factors.[11]

In the following the necessary information is provided for each of the environmental variables tested. First the environmental variable itself is presented, in descriptive text and in a table, showing the possible variables with the calculated area and proportion. It should be pointed out here that, often, the total area of a specific variable does not always correspond with the total area of the research region. This is because certain parts of a particular environmental dataset sometimes cannot be taken into account, for example because of lack of information for certain areas. A good example is the lack of soil type information for built-up areas such as towns. However, as each calculation is done specifically per environmental variable, this will not influence the reliability of the outcome of the Chi-squared calculation.

Datasets for the physical environment

The natural resources available within the study area have to be reconstructed using specific datasets, as introduced in chapter 3. Datasets for soils and open water are ready to use, however, information concerning variables such as slope, aspect and distance to water must be derived from other datasets.[12] Another important aspect to recognise in relation to the datasets of the physical environment is that they all represent the present-day situation. Due to the fact that the area has been inhabited and used almost continuously since the Roman period, with many large-scale invasive activities such as mining and the reshaping of waterways and land, it can be concluded that the datasets do not always reflect the exact situation of the Roman period. This influences the reliability of the outcome of the analyses in this chapter, but the lack of data for the Roman landscape means there is no alternative.

6.1 SETTLEMENT PATTERNS AND THE PHYSICAL ENVIRONMENT

In the following the settlement dataset is further explored by testing the distribution of the two sets of data against a range of variables, such as soils, elevation, distance to water, and distance to towns. The two datasets will first be analysed for each individual variable in order to identify correlations and significant trends. Then the multivariate analyses will be carried out, to establish possible relations between specific variables and the settlements.

6.1.1 SOILS

Relating settlement to soil type is one of the most commonly performed analyses in landscape archaeology. In a predominantly agrarian society the suitability of soils for arable farming is crucial. The

[10] Fletcher / Lock 2005, 132.

[11] Verhagen 2007, 47, citing a number of Dutch scholars that have pointed this out).

[12] I would like to thank Phillip Verhagen, GIS-specialist at the ACVU, for converting the DEM of the region into raster datasets for aspect and slope.

better the soil, the higher the possible crop yield. When it is assumed that the Roman rural settlements in the study area produced surplus cereals for the interregional market, it would follow that they were located on the loess soils. Therefore it is expected that a relation between soils and Roman rural settlements existed in the region. Looking at the different types of rural settlement, it is assumed that the stone-built settlements, representing the surplus-producing villa type, were located exclusively on the loess soils. Post-built farms, however, are not expected to have produced a surplus, and these are therefore expected on soils of lesser quality, for example in valleys with clay river deposits, or on sandy soils. These assumptions will be tested using the Chi-squared analysis.

Although the above seems straightforward, it has to be noted that the analysis of settlement patterns in relation to soil types is not without its problems. First of all, a major obstacle for this study is the fact that each of the three countries comprising the study area has its own system of soil classification, each with its own definition of soil types. It was decided to perform the analyses per area, however ,this meant that it was not possible to compare the results beyond a general level.

Another, often overlooked problem, relates to soil classification itself. When the possible relation between soil type and settlement is examined, the underlying assumption is that the people of the period concerned were aware of the differences in quality of the soil types within a region. And although it can be reasonably assumed that farmers in the Roman period knew which soils were fertile and easy to work,[13] it is less probable that they would classify soils according to the criteria used by earth scientists today. It should therefore be carefully considered which soil type classification to use, as results could quickly become meaningless. For example, if the difference between two subtypes can only be established based on chemical analysis of the mineral composition, it is highly doubtful whether a Roman farmer would have been able to distinguish between the two and therefore make an informed decision about the location of his settlement. Even though a bi-variate analysis could result in a statistical significant relation, the value of such a result could, rightfully, be questioned. In a way this is reflected in the soil classification effort by the FAO, whereby soils in the entire study area are classified as one type only, the so-called Cambisols.[14] Looking at the different maps of the distribution of soil types in the region (see for example figure 5.29 in the previous chapter), it is clear that loess soil is the dominant type. It can therefore be argued that to the Roman farmers, the entire region was considered to consist of this fertile and easy to work soil type, although with some regional variations. Any modern-day differentiation between types of soils would be an artificial construction, rather than a useful tool in the reconstruction of the Roman settlement landscape.

An additional problem is that, in the last 2000 years, geomorphologic processes, many of which are the result of human actions, have changed the composition of the soils. Soil erosion and manuring have created 'new' soil types, and it is doubtful whether the Roman farmer would have differentiated between what today are thought to be disparate soil types.

After careful deliberation it was decided to include the soil type in the analysis of rural settlements, however, using only the main soil types that can reasonably be said to have been significant in the Roman period, meaning for the study area, loess/loamy soils, clay, silt, sand and stony soils. This has resulted in a reclassified soil system, which may not be approved by earth scientists, but that, in my opinion, does justice to the perception of soils in the Roman landscape.

[13] See for example Cato's work on soil types.

[14] "Cambisols developed in medium and fine textured materials derived from a wide range of rocks, mostly in alluvial, colluvial and Aeolian deposits. Most of these soils make good agricultural land and are intensively used. Cambisols in temperate climates are among the most productive soils on earth." From FAO, 2007, World reference base for soil resources, first update. http://www.fao.org/ag/agl/agll/wrb/doc/wrb2007_corr.pdf

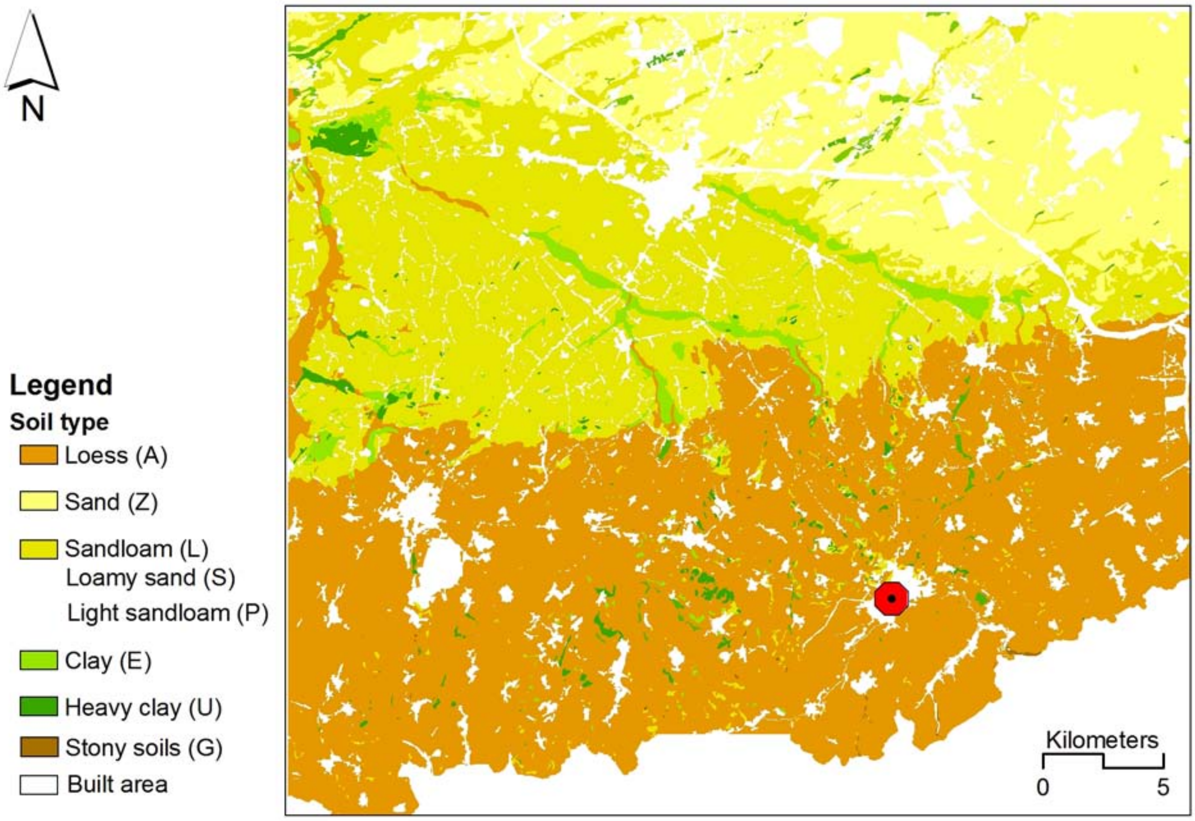


Fig. 6.3 Soil types in the Belgian part of the study area.

Soils in Belgian Limburg

The territory in the research region covered by Belgian Limburg boasts thirteen types of soil, five of which cover only very small areas (less than 1%). It was decided, therefore, to group these together and label them 'no value', together with the land covered by built-up areas today.

The map of the distribution of soil types clearly demonstrates that the region consists of three zones, each with its own dominant soil type: the loess soils (type A) in the southern part, the sandy soils (type Z) in the north-northeast, and the sand-loam soils (types L, S and P) in the centre-west of the region. Clay soils (E and U) are present only in limited areas, particularly in stream valleys. Table 6.1 shows the exact area per soil type.

soil type	description	area (ha)	proportion
A	Loess/ loam	56,339	48%
Z	Sand	21,624	19%
L	Sand-loam	20,470	18%
S	Loamy sand	8,552	7%
P	Light sand-loam	4,295	4%
E	Clay	2,574	2%
G	Stony soils	1,894	2%
U	Heavy clay	660	<1%

Tab. 6.1 Soil types in the Belgian part of the study area used in this study, arranged according to size and proportion.

The table shows that the loess/loamy soils (type A) are clearly the most widespread, with over 50,000 hectares, constituting nearly half of the region. The three sand-loam types (L, S and P) together form the second largest group, at 29%, followed by the sandy soils (Z) at 19%; less than 3% are clay soils and only 2% are stony soils.

In order to establish whether settlement in the Roman period favoured one or more soil types, first the distribution of settlements over the different types must be registered. Linking the settlement dataset to the soil map dataset in ArcGis, each site was provided with a value for the variable 'soil type'. Using both datasets (n=1186 and n=1944) resulted in the following values.

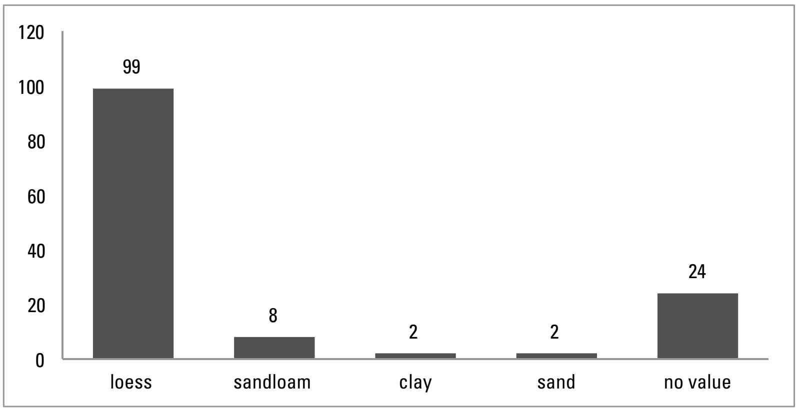


Chart 6.1 Frequency of settlements per soil type in the Belgian part of the study area for the dataset n=1186.

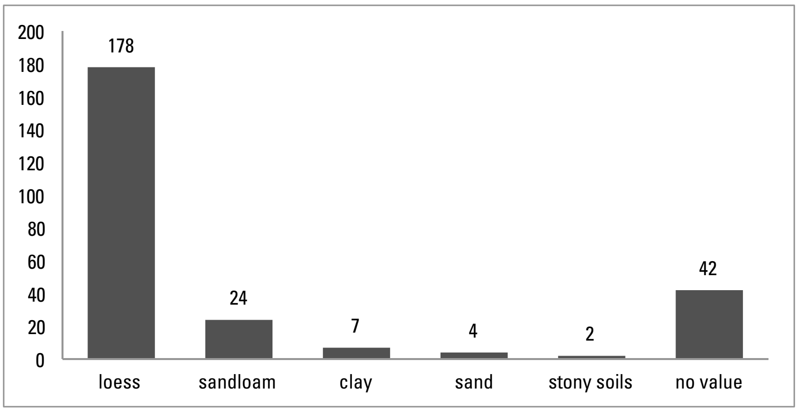


Chart 6.2 Frequency of settlements per soil type in the Belgian part of the study area for the dataset n=1944.

Interestingly when using the dataset n=1186, only five out of the eight soil types appear in the analysis. With the n=1944 dataset, all soil types are represented. However, in both cases settlement seems to have been located predominantly son the loamy soils. Comparison of the proportions per soil type of each of the two datasets demonstrates that the overall trends are very similar, in other words, using burial and non-classified evidence for the reconstruction of the settlement landscape (reflected in n=1944) has not resulted in a significantly different site distribution than from a distribution using settlement evidence alone (n=1186).

In order to estimate the significance of the distribution pattern, the expected number of settlements per soil type, based on the proportion of area of each type, must be compared to the observed numbers. The 'no value' items are left out of these calculations. In order to establish whether the observed frequen-

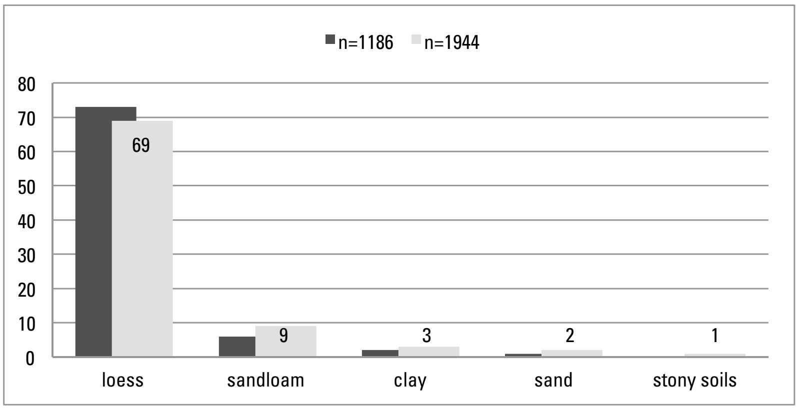


Chart 6.3 Percentages per dataset (for Belgian Limburg) per soil type.

cies are statistically significant compared to the expected frequencies, a Chi-squared value for each cell of the contingency table must be calculated. The results of these calculations are shown below.

Soil type	area (%)	n=1186 expected	observed	χ^2	n=1944 expected	observed	χ^2
loess	48	53	99	**39.92**	103	178	**54.61**
sand-loam	29	32	8	**18**	62	24	**23.29**
sand	18	20	2	**16.2**	39	7	**26.26**
clay	3	3	2	**0.5**	7	4	**1.29**
stony	2	2	0	**2**	4	2	**1**
TOTAL	**100**	**111**	**111**	**76.62**	**215**	**215**	**106.45**

Tab. 6.2 Calculation of Chi-squared for the variable 'soil type' for the datasets n=1186 and n=1944 in Belgian Limburg.

The table and charts above show that for both datasets far more settlements than expected are found on the loess soils, and that less settlements than expected are found on the other types of soils. In order to ascertain whether this observation is statistically significant, the observed Chi-squared values must be compared to the critical value applicable to this calculation.[15] For each Chi-squared calculation the null-hypothesis, or H_O, is always 'the two variables are NOT related'. Therefore, if the observed value is the same as the critical value or higher, the H_O is rejected and the alternative hypothesis, H_A , is accepted; H_A being 'the two variables ARE related'. The critical value is related to a percentage point, that indicates the chance, expressed in a percentage, of rejecting the original hypothesis (H_O), whilst it is true. The lower the percentage point, the higher the certainty that the observed (in)dependence of the two variables is true.

Table 6.3 shows that for both datasets the observed Chi-square value is higher than the critical value, and therefore allows for the rejection of H_O at the 0.1 level. In other words, H_O can comfortably be rejected, as the chance that it is rejected whilst being true is very small. Therefore it can be concluded that there was an association between soil type and settlement in Roman Belgian Limburg. This means that the settlement pattern in Belgian Limburg is evidence of a preference in Roman times for loess soils, over all other soil types in the region.

15 The critical values for all chi-squared calculations in this study are taken from the table in Fletcher / Lock 2005, 202.

	n=1186	n=1944
Chi-square (Observed value)	76.62	106.45
Chi-square (Critical value)	18.5	18.5
D.F.	4	4
Percentage point	0.1	0.1

Tab. 6.3 Results of the Chi-squared calculations for the variable 'soil type' for the datasets n=1186 and n=1944 in Belgian Limburg.

However, there is an important issue that has to be taken into account here, and that is the influence of current land-use, which can have a profound effect on how detectable archaeological remains are. The example of Belgian Limburg is appropriate to demonstrate this issue, as soil type continues to influence the use of land today. The southern half of Belgian Limburg, mainly consisting of loamy soils, is mostly used for arable farming, as demonstrated in chapter 2. This means that land there is regularly ploughed, and that it lies uncovered for at least part of the year. Obviously, this increases the detectability of any archaeological remains. Even when covered, for example by cereals, archaeological remains can still be detected, for example through aerial photography (crop marks).

The land in the west of the region, consisting predominantly of sandy loam soils, is less suitable for arable farming, and here orchards dominate the landscape. The lack of ploughing and coverage by trees and other vegetation means that archaeological remains are much harder to detect in comparison to on loamy soils. Non-invasive techniques such as field survey and aerial photography, are certain to yield few results under these circumstances. The sandy soils in the north of the region are almost

Fig. 6.4 Comparison of current-day land use in the area of the sand-loam soils (above left) and loess soils (right) in Belgian Limburg. Source for the aerial photos: Google Maps.

completely covered by forest today, and the area is much less densely populated, meaning that planned archaeological actions preceding building activities, or even the chances of accidentally uncovering archaeological remains are low. In light of this, it can be argued that the high proportion of settlements found on loamy soils is wholly or partly due to the differences in current-day land use of soil types in Belgian Limburg, rather than a reflection of settlement density differences in the Roman period.

The two aerial photographs of the two different zones, shown above in figure 6.4, reveal that, although there is a noticeable difference between how open the two regions are, arable farming is taking place even in the more marginal zones. In theory, this means that soil types other than the loess also offer a reasonable detectability of archaeological remains. It can therefore be argued that that the observed distribution of settlements over the main soil types represents a real pattern in Roman times.

Type of settlement – soil type

The next analysis concerns the type of rural settlement (interpreted at level 3) in comparison to soil type, in order to establish whether different soil types were favored by different types of settlements. We want to test whether all large stone-built 'villa' settlements were located on the loess soils, and whether post-built farms were confined to the more marginal soils. This means that, statistically, more stone-built settlements should be found on the loess soils, and less on the other types of soils, whereas the reverse should be true for post-built settlements.

In order to obtain reliable results, only settlements can be used for which both the type of settlement and the soil type is known, therefore the 'settlement-undefined' and 'soil type – no value' items are left out of the calculation. The contingency table demonstrates the number of items per soil type per settlement type. Using the dataset n=1186, a total of 111 settlements were used in the Chi-squared calculation for the Belgian territory.

	clay	**loess**	**sand**	**sand-loam**	**total**
SB	2	94	2	8	106
PB	0	5	0	0	5
Total	**2**	**99**	**2**	**8**	**111**

Tab. 6.4 Contingency table of settlement type per soil type, for the Belgian part of the dataset n=1186.

Table 6.4 shows that in the n=1186 dataset, only 5 post-built settlements could be used for the Chi-squared calculation, all of which were located on loess soils. The general rule is that for a Chi-squared calculation to be valid it is important that all expected frequencies are 5 or more, but for tables larger than 2x2 no more than 20% of all cells should have expected frequencies less than 1.[16] The contingency table for 'Post-built site - type of soil' however has 5 cells, 3 of which have an expected frequency of less than 1, which means more than 20%; therefore the results of the Chi-squared calculation are not valid for this particular part of the dataset. Nevertheless, the fact that all five post-built sites were located on the loess, rather than on sand or clay, indicates that the assumption made earlier does not hold true.

The category of stone-built settlements can be used, as only one of the cells has an expected value lower than 1. Table 6.5 shows that the observed Chi-squared value for the stone-built settlement dataset of n=1186 is 71.21, which means that the null-hypothesis can be rejected at the 0.1 percentage point. it can thus be statistically proven that the stone-built settlements in Belgian Limburg show a preference for loess soils over all other types.

16 Fletcher / Lock 2005, 131; the expected frequencies in this part are determined by the proportions of soil types in the region.

Soil type	area (%)	n=1186 post-built		$\chi 2$	n=1186 stone-built		$\chi 2$
		expected	observed		expected	observed	
loess	48	2.4		-	51	94	**36.54**
sand-loam	29	1.5		-	31	8	**16.82**
sand	18	0.9		-	19	2	**15.29**
clay	3	0.15		-	3	2	**0.44**
stony	2	0.1		-	2	0	**2.12**
TOTAL	**100**	**5,05**		**-**	**106**	**106**	**71.21**

Tab. 6.5 Calculation of Chi-squared for the variable 'soil type' per rural settlement type, for the dataset n=1186 in Belgian Limburg.

type	loess	sand-loam	sand	clay	stony soils	Total
Post-built	43	11	3	2	1	60
Stone-built	128	13	2	2	1	146
Total	**171**	**24**	**5**	**4**	**2**	**206**

Tab. 6.6 Contingency table of settlement type per soil type, for the Belgian part of the dataset n=1944.

Using the n=1944 dataset, the number of post-built settlements is much higher (n=60), compared to the dataset n=1186.[17] Calculating the expected frequencies for this dataset shows that the criterion for the validity of the Chi-squared analysis is met, as all expected frequencies are higher than 1 (below).

Soil type	area (%)	n=1944 post-built		$\chi 2$	n=1944 stone-built		$\chi 2$
		expected	observed		expected	observed	
loess	48	29	43	**7**	70	128	**47.87**
sand-loam	29	17	11	**2.35**	42	13	**20.33**
sand	18	11	3	**5.63**	26	2	**22.43**
clay	3	2	2	**0.02**	4	2	**1.29**
stony	2	1	1	**0.03**	3	1	**1.26**
TOTAL	**100**	**29**	**60**	**15.04**	**146**	**146**	**93.19**

Tab. 6.7 Calculation of Chi-squared for the variable 'soil type' per rural settlement type, for the dataset n=1944 in Belgian Limburg.

As with the n=11886 dataset, the null-hypothesis can be rejected and the alternative hypothesis ('the two variables are related') accepted at the 0.1 level for the stone-built rural settlements in n=1944. The relation between the two is therefore statistically proven. For post-built settlements the null-hypothesis can be rejected at the 1% level, meaning that for this type too soil type seems to have been a significant factor. However, the evidence shows that the post-built type was also found on the loess soils in

17 Of course it has been taken into consideration that the evidence for post-built settlements in the dataset n=1944 was not as reliable as for those in the dataset n=1186.

N=1944 – Belgian Limburg	Stone-built	Post-built
Chi-square (Observed value)	93.19	15.04
Chi-square (Critical value)	18.5	13.3
D.F.	4	4
Percentage point	0.1	1

Tab. 6.8 Comparison of Chi-squared values for the dataset n=1944, per type of settlement.

significantly more numbers. This means that the assumption that loess soils were the exclusive domain of stone-built settlements, and that post-built settlements were found on marginal soils only, cannot be proven for the Belgian part of the study area.

Soils in Dutch Limburg

Soils in Dutch Limburg are grouped into several categories, seen in the map below, with each main category containing different subtypes, incomparable to the groups used in Belgium. In the Dutch system, the loess soils fall under the letters B and A, whereas the letters Z and H indicate types of sandy soil. The soils grouped under L, R, M and F are clays and silts, with K indicating soils containing a

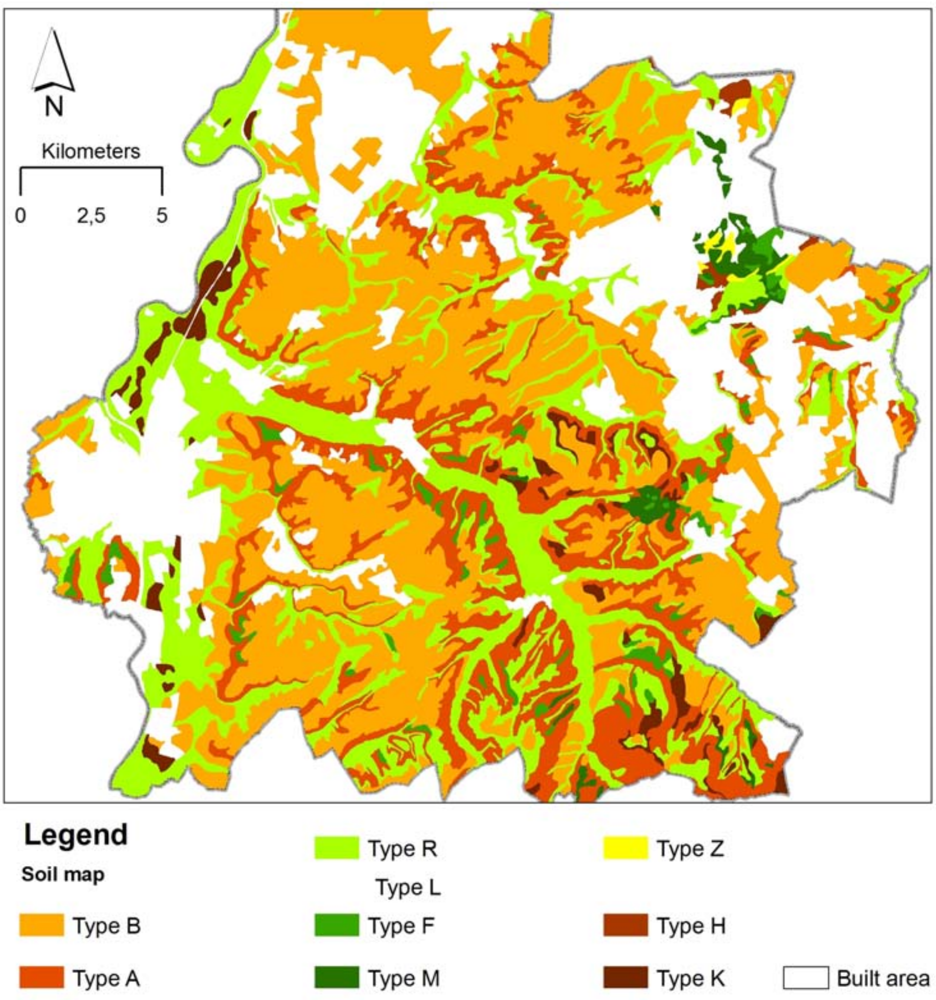


Fig. 6.5 Soil types in the Dutch part of the study area.

high proportion of stone. For this study it was decided to use only the main categories and, as for the Belgian region, soil types comprising less than 1% of the total surface were left out of the analysis. The soil map, below, shows that, unlike the Belgian region, the soil distribution in Dutch Limburg is highly mixed. It also demonstrates the size of the urban built-up areas in the region, which is one of the most densely populated in The Netherlands. Naturally these urban areas have not been taken into account, as there is no information regarding the soil type.

code	description	area (ha)	proportion
A, B	Loess soils	31,643	61%
L,R	Silt and clay soils	14,889	29%
K	Stony soils	3,116	6%
F, M	Clay soils	1,695	3%
H	Sandy soils	237	1%

Tab. 6.9 Soil types in Dutch Limburg used in this study, arranged according to size and proportion.

Table 6.9 demonstrates that the most common soil type in the Dutch part of the study area is the loess, followed by silts and clays. Interestingly, clays are less common than stony soils, and only a very small proportion consist of sandy soils.

The next step was to establish the number of settlement settlements per soil type for both datasets n=1186 and n=1944. This was then compared to the expected proportion, in order to establish a pos-

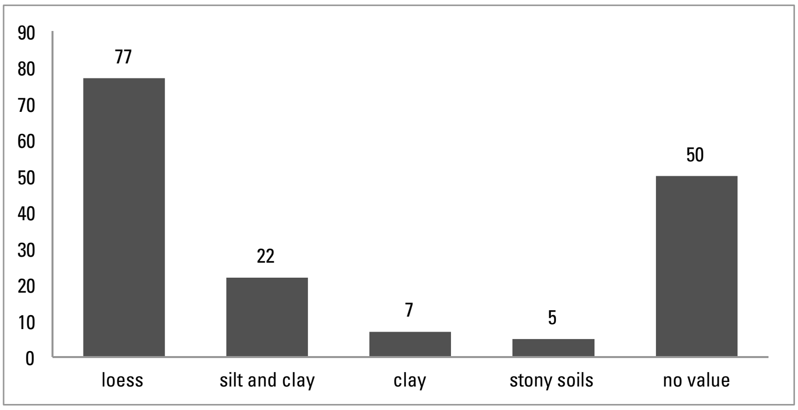


Chart 6.4 Frequency of settlements per soil type, for the Dutch part of the dataset n=1186.

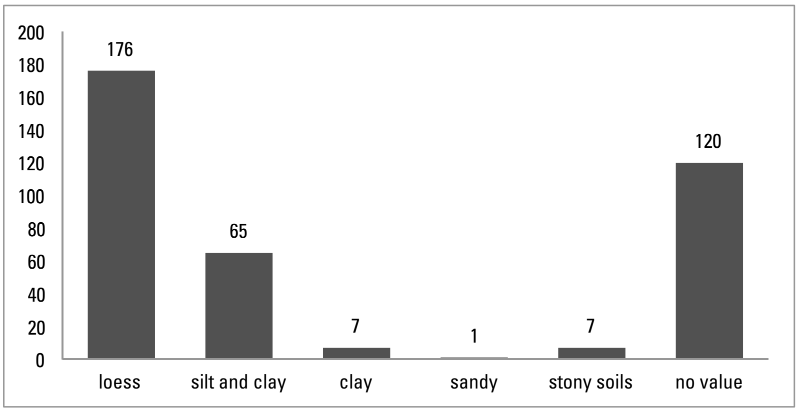


Chart 6.5 Frequency of settlements per soil type, for the Dutch part of dataset n=1944.

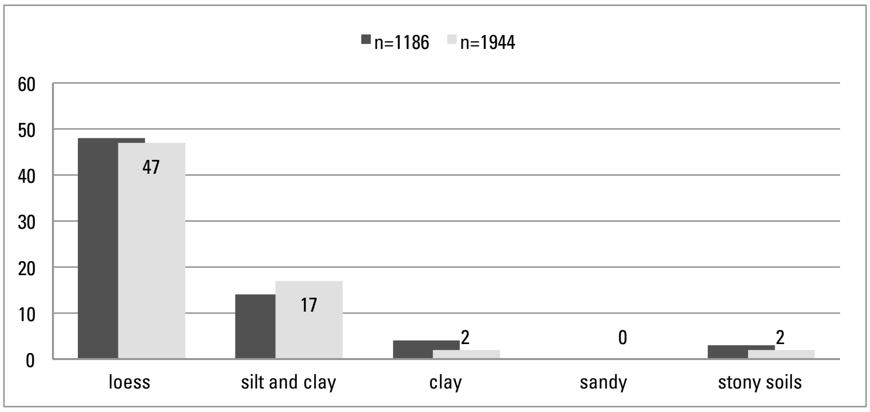


Chart 6.6 Percentages per soil type per dataset for Dutch Limburg.

sible connection between settlements and soil type. In the calculation of Chi-square, the settlements with 'no value' are left out, and, interestingly, this means that using the dataset n=1186 the exact same number of settlements were used as for Belgian Limburg, namely 111.

The bar charts (above and below) demonstrate that most settlements were found on the loess soils, followed by the silts and clays. As with the sample on Belgian territory, the two settlement datasets did not demonstrate striking differences in site distribution over the different soil types.

The number of settlements observed per soil type have then been compared to the expected number, in order to calculate the Chi-square values.

Soil type	area (%)	n=1186			n=1944		
		expected	observed	χ^2	expected	observed	χ^2
loess	61	68	77	**1.27**	156	176	2.52
silt and clay	29	32	22	**3.23**	74	65	1.15
stony	6	7	5	**0.41**	15	7	4.55
clay	3	3	7	**4.04**	8	7	0.06
sandy	1	1	0	**1.11**	3	1	0.95
TOTAL	**100**	**111**	**111**	**10.07**	**256**	**256**	**9.23**

Tab. 6.10 Calculation of Chi-squared for the variable 'soil type' for the datasets n=1186 and n=1944 in Dutch Limburg.

	n=1186	n=1944
Chi-square (Observed value)	10.07	9.23
Chi-square (Critical value)	9.49	7.78
D.F.	4	4
Percentage point	5	10

Tab. 6.11 Results of the Chi-squared calculations for the settlement datasets in Dutch Limburg.

Table 6.11 shows that, allowing for the rejection of the null-hypothesis at the 0.1 percentage point, the Chi-square values observed are quite low in comparison to the values for the Belgian datasets. The Dutch part of the dataset n=1186 allows for rejection only at the 5% level, whereas for the n=1944 it can be rejected only at the 10% level. These numbers indicate that, although preference for soil type can be observed, the relation is somewhat weaker than in the region west of the Meuse.

It should be noted that, in the case of the silts and clays, post-depositional processes could have played an important role in the settlements-per-soil type analysis. Most of these soils are situated in valleys created by small streams, such as the Gulp and Geul. The sides of these valleys are quite steep, and geophysical research has proved that soil erosion of them has resulted in an accumulation of colluvium on the valley floors, sometimes several metres deep. Some of this soil erosion took place in the Roman period, but it happened at a much higher rate in the Medieval period and continues today.[18] It can, therefore, be assumed that settlements located in these valleys are significantly harder to detect than settlements located on the slopes and plateaus of South Limburg, where the loess soils are found. Nonetheless, even when it is assumed that the number of settlements on the loess soils do not represent the original situation in Roman times, the fact that most of the settlements are found on these soils remains undisputed.

type	loess	silt-clay	stony	clay	sandy	total
post-built	3	2	0	0	0	5
stone-built	74	19	5	7	0	105
TOTAL	**77**	**21**	**5**	**7**	**0**	**110**

Tab. 6.12 Contingency table of the set of variables 'type of settlement' – 'soil type' for n=1186 in Dutch Limburg.

In examining the settlement patterns of the two main types of rural settlements in comparison to the soil types, the same problem as in Belgian Limburg arises when using the n=1186 dataset. Three out of the five cells have an expected frequency lower than 1, meaning the results of the Chi-squared calculation for the post-built sites in this dataset cannot be used. The category of stone-built settlements, however, can be used, as only one of the cells has an expected value lower than 1.

	area (%)	n=1186 post-built		χ^2	n=1186 stone-built		χ^2
		expected	observed		expected	observed	
loess	61	4	3	-	64	74	**1.55**
silt and clay	29	2	2	-	30	19	**4.31**
stony	6	0	0	-	6	5	**0.27**
clay	3	0	0	-	3	7	**4.71**
sandy	1	0	0	-	1	0	**1.05**
TOTAL	**100**	**6**	**5**	-	**104**	**106**	**11.88**

Tab. 6.13 Calculation of Chi-squared for the variable 'soil type' per rural settlement type, for the dataset n=1186 in Dutch Limburg.

Table 6.13 shows that the observed Chi-squared value for the stone-built settlement dataset of n=1186 is 11.88, which means that the null-hypothesis can be rejected at the 5 percentage point (=11.1). This means that there is a statistically significant relation between stone-built settlements and soil type, although the evidence is not as strong as it is west of the Meuse. It has to be pointed out, that, even though the post-built type could not be tested, the actual numbers per soil type indicate that instead of being confined to the more marginal soils, this settlement type was also found on the loess.

[18] De Moor 2006, 64-65.

type	loess	silt and clay	stony	clay	sandy	total
post-built	73	22	1	0	1	97
stone-built	80	23	5	7	0	115
TOTAL	**153**	**45**	**6**	**7**	**1**	**212**

Tab. 6.14 Contingency table of settlement type per soil type, for the Dutch part of the dataset n=1944.

There are 97 post-built settlements in the n=1944 dataset for Dutch Limburg, and the Chi-squared analysis is valid, as all expected frequencies are higher than 1 (see table 6.15, below).

	area (%)	n=1944 post-built		$\chi 2$	n=1944 stone-built		$\chi 2$
		expected	observed		expected	observed	
loess	61	59	73	**3.23**	70	80	**1.38**
silt and clay	29	28	22	**1.34**	33	23	**3.21**
stony	6	6	1	**3.99**	7	5	**0.52**
clay	3	3	0	**2.91**	3	7	**3.65**
sandy	1	1	1	**0**	1	0	**1.15**
TOTAL	100	97	97	**11.47**	115	115	**9.92**

Tab. 6.15 Calculation of Chi-squared for the variable 'soil type' per rural settlement type, for the dataset n=1944 in Dutch Limburg.

N=1944 – Dutch Limburg	stone-built	post-built
Chi-square (Observed value)	9.92	11.47
Chi-square (Critical value)	9.49	9.49
D.F.	4	4
Percentage point	5	5

Tab. 6.16 Comparison of Chi-squared values for the dataset n=1944, per type of settlement.

Table 6.16 shows that the observed Chi-squared values were rather low, especially when compared to the values obtained for the Belgian part of the study area. For the group of stone-built settlements, especially, the fact that the null-hypothesis can only be rejected at the 5% level, compared to the 0.1% level of the same group west of the Meuse, seems to indicate that the evidence in the Dutch area for a significant relation between settlement type and soil type is not as strong. Interestingly, the value for post-built settlements is the same as that of the Belgian dataset. Also of interest is that there were more stone-built settlements than expected on the clay soils, which can be considered as somewhat out-of-character because this fertile, but hard to work soil type is seen as marginal in the loess zone and one would expect post-built settlements there rather than stone-built settlements. However, the opposite seems to be true, as post-built settlements were not found on the clay soils.

The strength of the association can be tested using the calculation of Cramer's V. With the results of the n=1944 table, V = 0.2, which indicates that the association is quite weak.[19] So even though the

[19] Cramer's V values range from 0 to 1, 0 indicating a very weak association, and 1 indicating a very strong association. See Fletcher / Lock, 2005, 133.

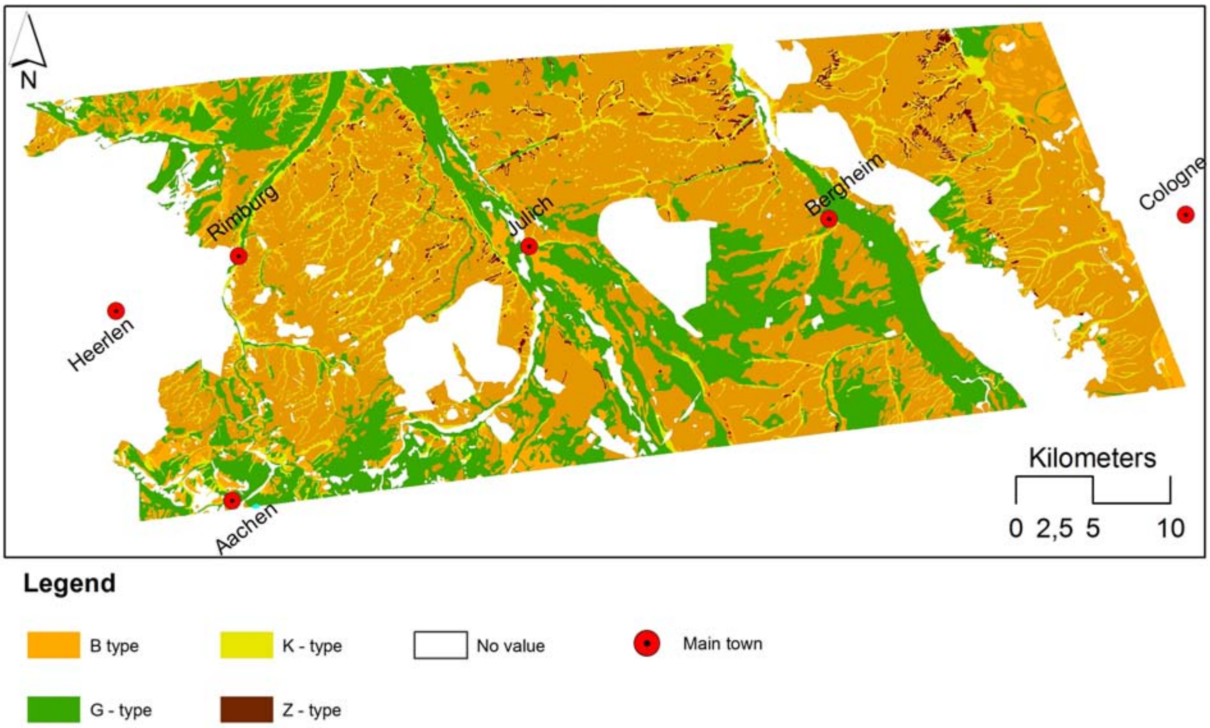


Fig. 6.6 Soil types in the German part of the study area.

Dutch dataset does point toward a pattern whereby particular settlement types are more likely to be associated with certain soil types, the association is not as strong as might be expected, based on the assumptions outlined at the beginning of this chapter.

Soil types in the German Rhineland

The classification for soils found in the German part of the study area is very different from that in the other two countries. For reasons explained earlier, it was decided to group together the types B and L (brown earth soils, fertile and easy to work), and G and S (gley, clay, sticky and hard to work). Types K (colluvium soils), Vega and Pararendzina (stony soils) are used by themselves. As previously, soil types representing less than 1% of the total area were grouped together as 'no value', together with the built-up areas and, in this part of the study area, the large areas destroyed by the lignite mines. The resulting areas and proportions are shown in table 6.17.

code	description	area (ha)	Proportion
B, L	Brown earth	86,230	63%
G, S	Gley	34,519	25%
K	Kolluvisol	13,135	10%
Z	Pararendzina	1,625	1%
A	Vega	849	1%
-	Built area / open pit mine	25,387	16%

Tab. 6.17 Soil types in the German part of the study, according to their size and proportion.

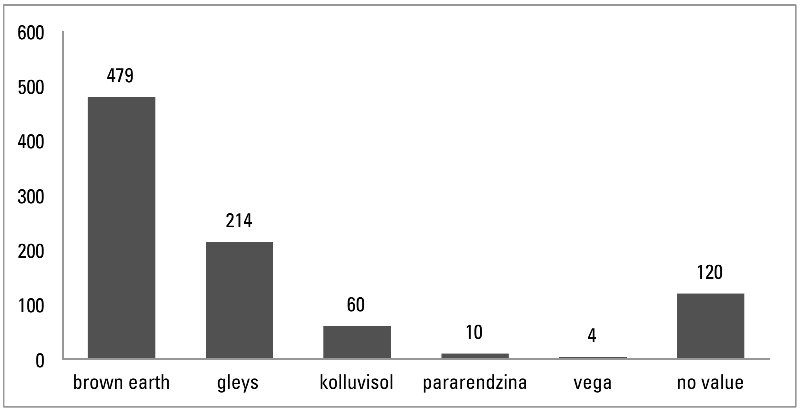


Chart 6.7. Frequencies per soil type for the German part of the dataset n=1186.

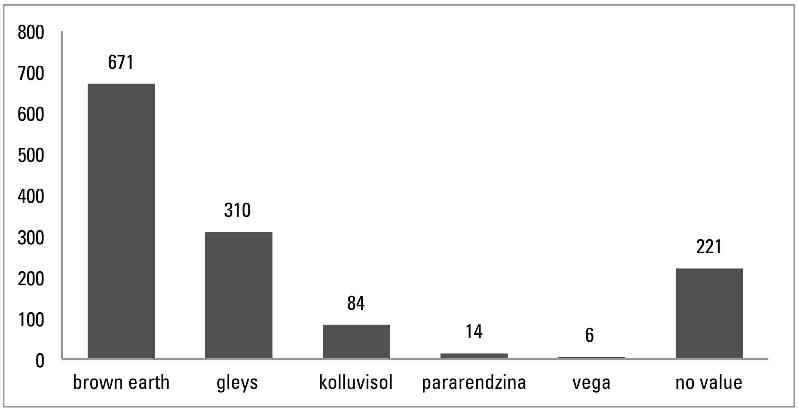


Chart 6.8 Frequencies per soil type for the German part of the dataset n=1944.

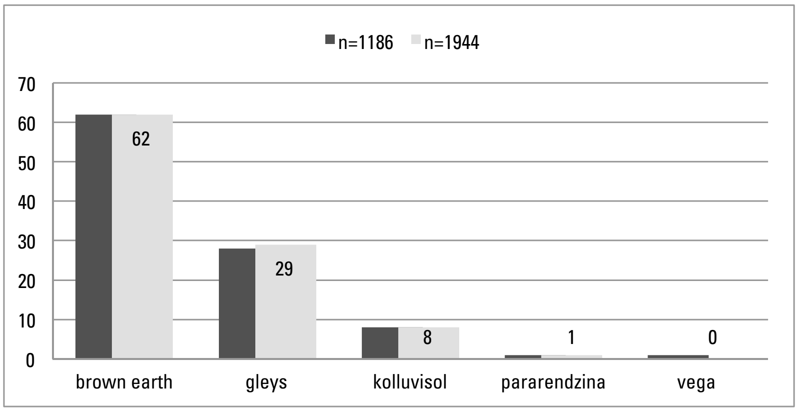


Chart 6.9 Percentages per dataset per soil type for the German Rhineland.

As with the other two examples, there seems to be no real difference between the results of the Chi-squared analyses for the two different datasets n=1186 and n=1944.

	area (%)	n=1186			n=1944		
		expected	observed	χ^2	expected	observed	χ^2
Brown earths	63	483	479	**0.04**	684	671	**0.23**
Gleys	25	192	214	**2.58**	271	310	**5.54**
Kolluvisol	10	77	60	**3.64**	109	84	**5.53**
Pararendzina	1	8	10	**0.71**	11	14	**0.91**
vega	1	8	4	**1.76**	11	6	**2.17**
TOTAL	**100**	**767**	**767**	**8.72**	**1085**	**1085**	**14.38**

Tab. 6.18 Calculation of Chi-squared for the variable 'soil type' for the datasets n=1186 and n=1944 in the German Rhineland.

The results in table 6.18 show that, compared to the Dutch and Belgian part of the study area, evidence for a marked preference in settlement on the fertile brown earth soils is not very strong. Interestingly, more settlements than expected are found on the harder to work *gley* soils.

	n=1186	n=1944
Chi-square (Observed value)	8.72	14.38
Chi-square (Critical value)	7.78	13.3
D.F.	4	4
Percentage point	10	1

Tab. 6.19 Results of the Chi-squared calculations for the settlement datasets in Germany.

For the dataset n=1186, the Chi-square value is low, especially compared to values for the Belgian and even the Dutch parts of the dataset. In fact, although it does allow for the rejection of the null-hypothesis, it only does so at the 10 percentile point, meaning there is a 10% chance of the null-hypothesis being true and thus wrongly rejected. The dataset n=1944, however, allows for the rejection of the null-hypothesis at the 1% level, which means that, for this dataset, the relation between soil type and settlement is proven with more reliability than for the dataset n=1186. The individual Chi-square values per cell, however, indicate that, here, the most significant connections are with *gley* soils (more settlements than expected) and with the *kolluvisol* soils (fewer settlements than expected).

When examining the distribution of the two main types of rural settlement in comparison to the soil types, it is evident that the category of post-built settlements of the dataset n=1186 will not result in reliable values of Chi-squared for the German territory (see table 6.20) as there are only two settlements that can be used in the calculation. Unfortunately, the majority of settlements located in the lignite mining areas are in the 'no value' category, as the soil map used does not provide information on the soils in the mining areas. It is here that the majority of post-built settlements, found through invasive research, were located, and thus feature in the dataset n=1186.

type	Brown earth	Gley	Kolluvisol	Pararendzina	Vega	Total
post-built	1	0	1	0	0	2
stone-built	472	212	58	10	4	756
TOTAL	**473**	**212**	**59**	**10**	**4**	**758**

Tab. 6.20 Contingency table for the dataset n=1186 in Germany, for the set of variables 'type of settlement' and 'soil type'.

The category of stone-built settlements, however, can be used and the results of the Chi-squared calculation for this dataset are shown below in table 6.21.

With a Chi-squared value of 9.4 and a d.f.[20] of 4, the null-hypothesis can be rejected at the 5% level, meaning that the relation between stone-built settlements and soil types is statistically significant. However, as noted earlier, it may come as a surprise that the individual values demonstrate that the preference of stone-built settlements for brown earths is not as marked as may be expected, as in fact slightly less settlements than expected were found on this soil type. Table 6.21 demonstrates that it was the *gley* soil type where far more sites were found than expected. The *kolluvisol* soil type seems to have been actively avoided by stone-built settlements.

[20] Degrees of Freedom: this is calculated as follows: d.f.= (r-1)(c-1), where r= number of rows and c= number of columns, of the contingency table used in the Chi-squared calculation.

	area (%)	n=1186 stone-built rural		χ^2
		expected	observed	
Brown earth	63	476	472	**0.04**
Gley	25	189	212	**2.8**
Kolluvisol	10	76	58	**4.1**
Pararendzina	1	8	10	**0.79**
Vega	1	8	4	**1.68**
TOTAL	**100**	**756**	**756**	**9.4**

Tab. 6.21 Calculation of Chi-squared for the variable 'soil type' for stone-built rural settlements for dataset n=1186 in the German Rhineland.

Using the dataset n=1944, there are sufficient post-built settlements to obtain a reliable Chi-squared calculation, as there are no expected values lower than 1 (see table 6.22).

	Brown earth	Gley	Kolluvisol	Pararendzina	Vega	Total
Post-built	96	63	8	0	0	167
Stone-built	491	214	61	11	6	783
TOTAL	**587**	**277**	**69**	**11**	**6**	**950**

Tab. 6.22 Contingency table for the dataset n=1944 in Germany, for the set of variables 'type of settlement' and 'soil type'.

Based on the numbers in the contingency table, the Chi-squared values for post-built and stone-built settlements in relation to soil types were calculated.

	area (%)	n=1944 post-built		χ^2	n=1944 stone-built		χ^2
		expected	observed		expected	observed	
Brown earth	63	105	96	**0.81**	493	491	**0.01**
Gley	25	42	63	**10.82**	196	214	**1.7**
Kolluvisol	10	17	8	**4.53**	78	61	**3.82**
Pararendzina	1	2	0	**1.67**	8	11	**1.28**
vega	1	2	0	**1.67**	8	8	**0.43**
TOTAL	**100**	**167**	**167**	**19.49**	**783**	**783**	**7.25**

Tab. 6.23 Calculation of Chi-squared for the variable 'soil type' for the datasets n=1186 and n=1944 in the German Rhineland.

N=1944 – German Rhineland	stone-built	post-built
Chi-square (Observed value)	7.25	19.49
Chi-square (Critical value)	7.78	18.5
D.F.	4	4
Percentage point	10	0.1

Tab. 6.24 Comparison of Chi-squared values for the dataset n=1944 in the German Rhineland.

Table 6.24 shows that the Chi-square value observed for the post-built category allows for the rejection of the null-hypothesis at the 0.1 percentile point, meaning the relation between the two is statistically significant. Interestingly the post-built settlements seem to have a preference for the *gleys* soils (see value in table 6.23).

The same table also shows that the value for the stone-built group is very low, which means that, even at the 10% level, the null-hypothesis cannot be rejected, and therefore it must be concluded that, based on this evidence, a relation between stone-built settlements and soil type cannot be proven. According to this calculation, stone-built settlements were found on all possible soils in the region, including the more marginal soils, and a strong preference, for example, for the brown earths, cannot be established for this dataset. As with the settlement dataset in the other two countries, the evidence shows that the expected relation between post-built farms and poorer soils did not exist, and that the assumption that only stone-built villa settlements were located on the richer soils has to be rejected. It is also remarkable that in each of the analyses fewer settlements than expected were found on the *Kolluvisol* soils. This might be a distortion caused by the nature of the soil type, namely that of soil erosion. Settlement located on these soils could be covered in layers of colluvium and therefore be less likely to discovered, especially by means of non-invasive research which, as was shown already in chapter 4, has been the dominant type of research in this part of the study area.

Conclusions – settlement / soil type

The results of the chi-squared analyses for the relation between soil type and Roman settlements across the study area definitely indicated a preference for the more fertile loess soils. However, only west of the Meuse is this preference as dramatic as expected. East of the Meuse the differences between expected and observed numbers are much less marked, to the point where there hardly seems to have been any preference at all. This perceived lack of soil preference east of the Meuse should be further examined because of its implications. It could, for example, be the result of a specific settlement strategy, whereby settlement was more directed and controlled east of the Meuse, resulting in a more even distribution of settlers across the entire area. The pattern observed west of the Meuse, could be interpreted as a more organic settlement development, whereby the choice of settlement was not directed, resulting in a more pronounced soil preference pattern. Organised and controlled settlement can be interpreted as being typical of a colonized landscape. Since the land east of the Meuse formed the territory of two *colonias* and land west of the Meuse the territory of a regular *civitas* capital, the differences observed could be a reflection of different settlement patterns in the region. Another possible explanation could be, however, that, west of the Meuse, the difference between the loess and sandy soils is so pronounced that this encouraged settlement on the loess soils, whereas the differences between fertile and less fertile soils east of the Meuse are less pronounced.

The examination of the alleged association of certain settlement types with soil types has not resulted in the desired clear-cut patterns, whereby the stone-built group was thought to dominate the fertile soils, leaving the more marginal zones to post-built settlements . The evidence showed a more diverse distribution, and, although the fertile loess soils were preferred almost everywhere, it seems to have been dominated by post-built and stone-built settlements alike. Interestingly, stone-built settlements were also found on soils thought to be more marginal, such as the silt and clay soils in Dutch Limburg, and the *gley* soils in the German Rhineland.

It could be argued here that the classification as 'post-built' of the sites of the n=1944 dataset is not reliable and that therefore the outcome of the Chi-squared analysis regarding this subdataset is without meaning. It has to be accepted, however, that the small number of post-built sites identified in the n=1186 dataset demonstrated that this type of farms was also found on the fertile loess soils of the region, instead of the more marginal soils.

Further investigations are required to establish how present-day use of particular soil types influences the visibility of archaeological remains and thus the variety in settlement density. Interestingly, in most cases where fewer settlements were observed than expected, it can be argued that present-day land use was the cause. Until further investigation has taken place it can be concluded that soil type was an important factor to Roman settlement, but not to the point where it prohibited any or certain particular types of settlement.

6.1.2 DISTANCE TO WATER

Proximity to open water[21] is the next variable that landscape studies typically take into account when analysing the distribution of settlements. It is assumed that access to (open) water was a crucial settlement factor for the Roman period, and that, subsequently, land in closer proximity to waterways, however small, would have been more densely populated than other areas located at larger distances. In order to test this assumption, the study area was divided into 'distance to water'-bufferzones. Buffers were created for streams and rivers,[22] for the distances: 0-100m, 101-250m, 251-500m, 501-1000m, 1001-1500m, 1501-2000m and >2001m.[23] Figure 6.7 shows the location of several small brooks in the region northwest of *Atuatuca Tungrorum*/Tongres. Figure 6.8 then shows the result of the buffer creation for this region.

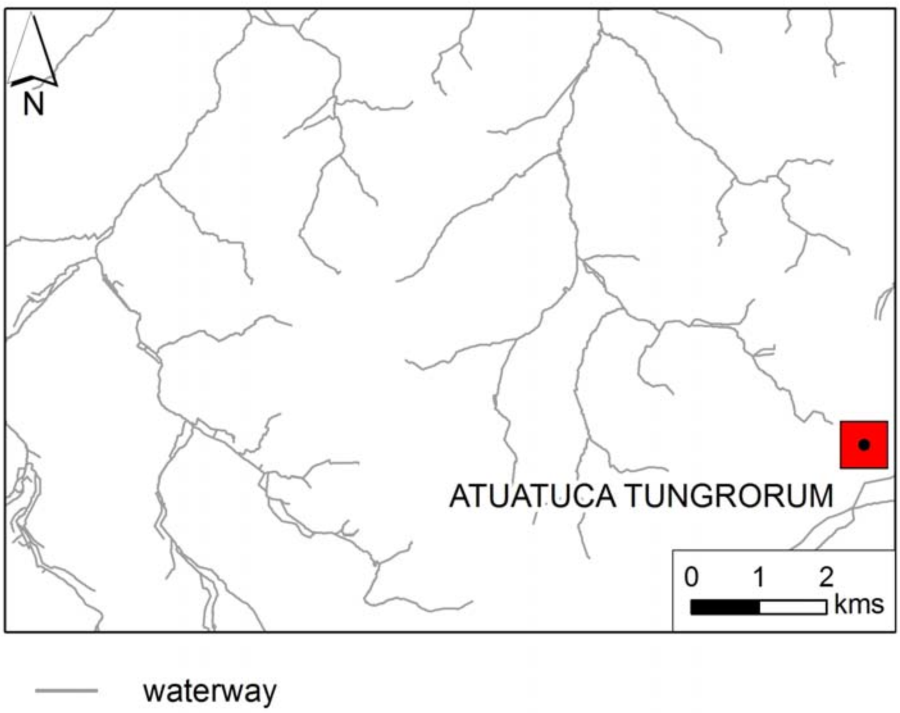


Fig. 6.7 Map of waterways west of Atuatuca Tungrorum in Belgian Limburg.

The map of the distribution of the different buffer zones demonstrates that there were few areas where the distance to the nearest source of fresh water is more than 2000 meter, but that there were pronounced differences from west to east.

21 As opposed to for example ground water, available through the use of wells.

22 Some of the small streams in the region do not carry water all year round, nevertheless they were incorporated into this analysis.

23 The buffers were created using the 'Proximity' tool in the spatial analysis toolbox of ArcMap 9.2.

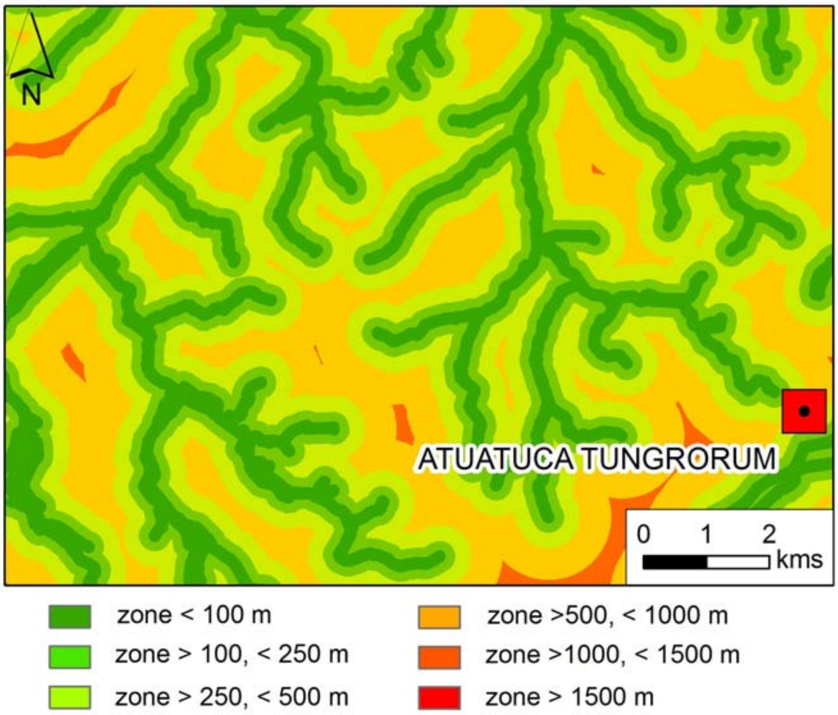


Fig. 6.8 Map of the same area as 6.7, shown with the different distance-to-water buffers.

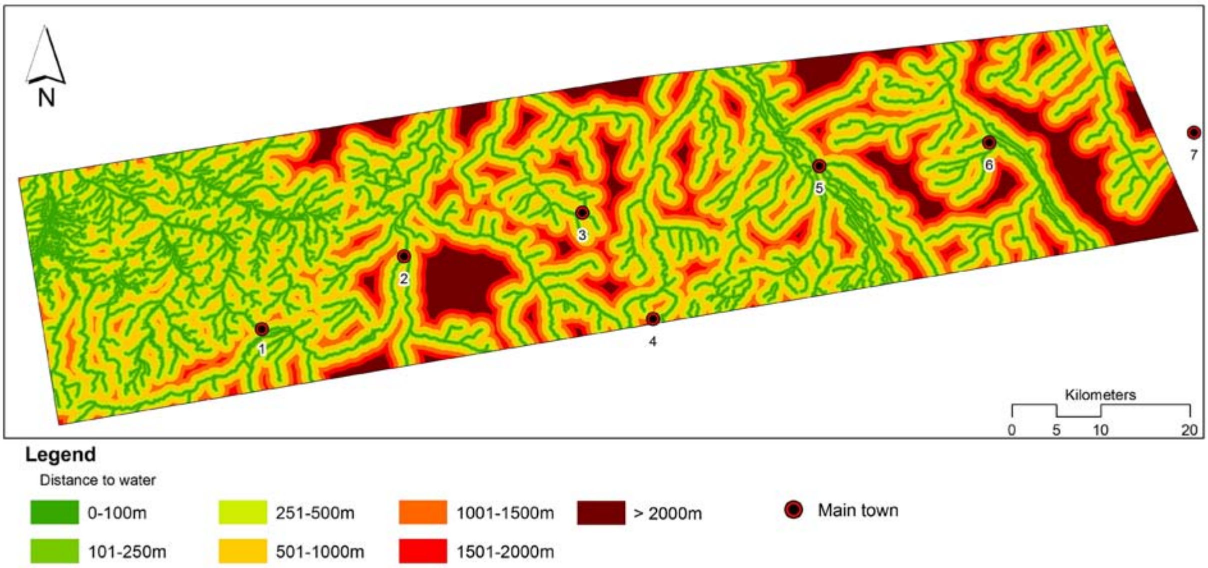


Fig. 6.9 Distance to nearest stream zones in the study area.

The next step is to determine, for each settlement, in which 'distance to water' zone it was located, using the 'select by location' tool in ArcMap. This way a the new variable 'distance to water' was added to the datasets. Unlike the soil types, the 'distance to water'-variable could be determined for the entire dataset. The results of this exercise is shown below in charts 6.10 and 6.11.

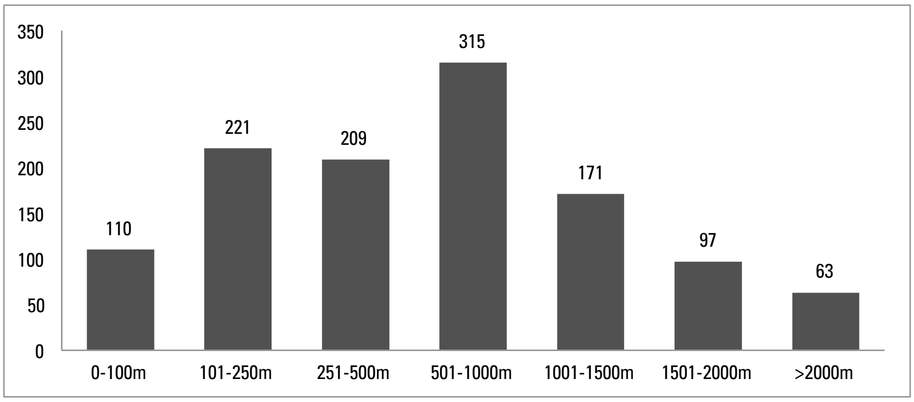


Chart 6.10 Frequencies per distance to water zone for the dataset n=1186.

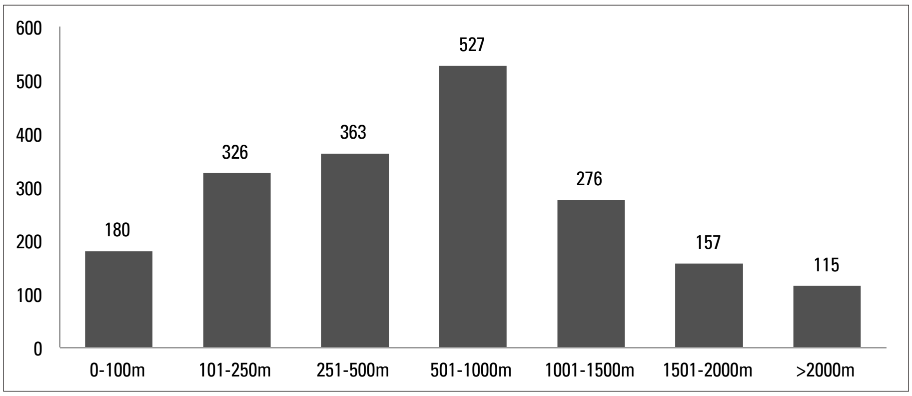


Chart 6.11 Frequencies per distance to water zone for the dataset n=1944.

Before it can be established whether the distribution of the number of settlements per distance zone is evidence of a particular settlement preference, the area of each buffer zone needed to be calculated. These are shown in table 6.25. With the observed proportion of areas of each buffer zone the Chi-squared values were calculated for n=1186 and n=1944, the results of which are shown in table 6.26.

Distance to water buffer zone	**area (ha)**	**%**
0-100	43,014	12
101-250	53,500	15
251-500	69,962	20
501-1000	86,777	24
501-1500	46,411	13
1501-2000	25,064	7
>2000	30,754	9

Tab. 6.25 Distance to water zones with their area and proportion.

For both datasets, the observed Chi-squared value allows for the rejection of the null-hypothesis at the 0.1 percentile, proving that the relation of settlements to the variable 'distance to water' is dependent. In other words, it can be concluded that distance to water was of influence on settlement in the Roman period. However, the results do not translate into a linear concept of 'the closer the better', as the individual observations indicate that the first 100 metres on both sides of a stream are apparently less attractive to settlement, with significantly less settlements than expected. As these zones are usu-

Distance zone	area (%)	n=1186 expected	observed	χ^2	n=1944 expected	observed	χ^2
0-100m	12	142	110	**7.21**	233	180	**12.06**
101-250m	15	177	221	**10.93**	292	326	**3.96**
251-500m	20	238	209	**3.53**	389	363	**1.74**
501-1000m	24	285	315	**3.15**	467	527	**7.71**
1001-1500m	13	154	171	**1.88**	253	276	**2.09**
1501-2000m	7	83	97	**2.36**	135	157	**3.59**
>2000m	9	107	63	**18.09**	175	115	**20.57**
TOTAL	**100**	**1186**	**1186**	**47.17**	**1944**	**1944**	**51.71**

Tab. 6.26 Calculation of Chi-squared for the variable 'distance to water' for the datasets n=1186 and n=1944.

	N=1186	N=1944
Chi-square (Observed value)	47.17	51.71
Chi-square (Critical value)	22.5	22.5
D.F.	6	6
Percentage point	0.1	0.1

Tab. 6.27 Results of the Chi-squared calculation for the variable 'distance to water' for the datasets n=1186 and n=1944.

ally quite wet, especially during spring and autumn, when there is a greater chance of flooding, the advantage of living in such close proximity of a fresh water source would probably be out weighted by the disadvantage of habitation in wet conditions. There is, however, another possible explanation for the 'emptiness' of this zone. Typically land bordering on water provides good grazing meadows and even today this zone is often used as pasture for cattle, as shown in figure 6.10, below. Similar use could have resulted in a lower number of settlements in close proximity to water in the Roman period. The zones of 101-250 metres and 501-1000 metres distance seem to have been most favoured; the zone where distance to water exceeds two kilometres seems to have been actively avoided.

After establishing the dependence between settlements and the distance to the nearest stream, the next step is to compare the distribution of the two types of rural settlements over the different distance-to-water zones. This way the assumption can be tested that stone-built settlements occupied the more favourable locations in the region, in this case the land in closer proximity to water.

type	0-100m	101-250m	251-500m	501-1000m	1001-1500m	1501-2000m	>2000m	Total
Post-built	2	4	2	9	7	3	4	31
Stone-built	107	217	204	300	164	94	59	1145
TOTAL	**109**	**221**	**206**	**309**	**171**	**97**	**63**	**1176**

Tab. 6.28 Contingency table for the observed frequencies of settlement type in relation to distance to water, for the dataset n=1186.

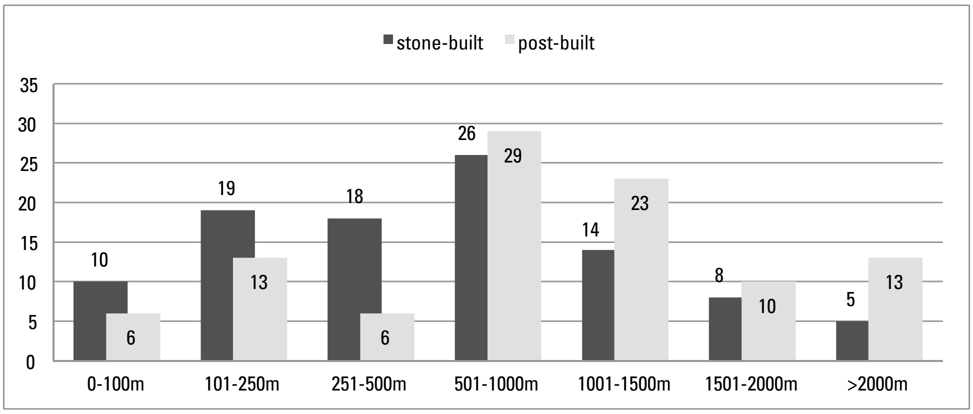


Chart 6.12 Proportions of settlements per distance-to-water zones, for the two types of rural settlement, using n=1186.

Distance zone	area (%)	n=1186 post-built		χ^2	n=1186 stone-built		χ^2
		expected	observed		expected	observed	
0-100m	12	4	2	**0.8**	137	107	**6.73**
101-250m	15	5	4	**0.09**	172	217	**11.92**
251-500m	20	6	2	**2.85**	229	204	**2.73**
501-1000m	24	7	9	**0.33**	275	300	**2.31**
1001-1500m	13	4	7	**2.19**	149	164	**1.54**
1501-2000m	7	2	3	**0.32**	80	94	**2.39**
>2000m	9	3	4	**0.52**	103	59	**18.83**
TOTAL	**100**	**31**	**31**	**7.09**	**1145**	**1145**	**46.45**

Tab. 6.29 Calculation of Chi-squared for the variable 'distance to water' per rural settlement type for the dataset n=1186.

N=1186	Post-built	Stone-built
Chi-square (Observed value)	7.09	46.45
Chi-square (Critical value)	10.6	22.5
D.F.	6	6
Percentage point	10	0.1

Tab. 6.30 Results of the Chi-squared calculation for the variable 'distance to water' per settlement type for the dataset n=1186.

Table 6.30 shows that for the post-built settlements of the dataset n=1186 the null-hypothesis cannot be rejected whereas for the stone-built group it can be rejected at the 0.1 percentile level. According to this information, proximity to water apparently was not a settlement factor for post-built settlements, but a significant factor for stone-built sites. Looking at the numbers for the individual distance zones, stone-built sites seemed to prefer a location in close proximity to water, yet at more than 100 metres distance. Locations more than 2000 metres away of a stream were avoided. Nonetheless, even the zones located relatively far from a stream (500 to 2000 metres) seemed to have been in demand by stone-built settlements.

Fig. 6.10 The river Geul near the village of Partij in Dutch Limburg, showing how, today, land bordering on open water is typically used as pasture for cattle, with the arable fields located further away.

The same analysis was performed using the dataset n=1944. With this dataset the proportions per distance-to-water zone for each of the two settlement types are very similar, as can be seen in chart 6.13.

Type	0-100m	101-250m	251-500m	501-1000m	1001-1500m	1501-2000m	>2000m	Total
Post-built	40	57	74	120	64	38	36	429
Stone-built	111	237	223	324	175	100	68	1238
TOTAL	**151**	**294**	**297**	**444**	**239**	**138**	**104**	**1667**

Tab. 6.31 Contingency table for settlement type in relation to distance to water, for the dataset n=1944.

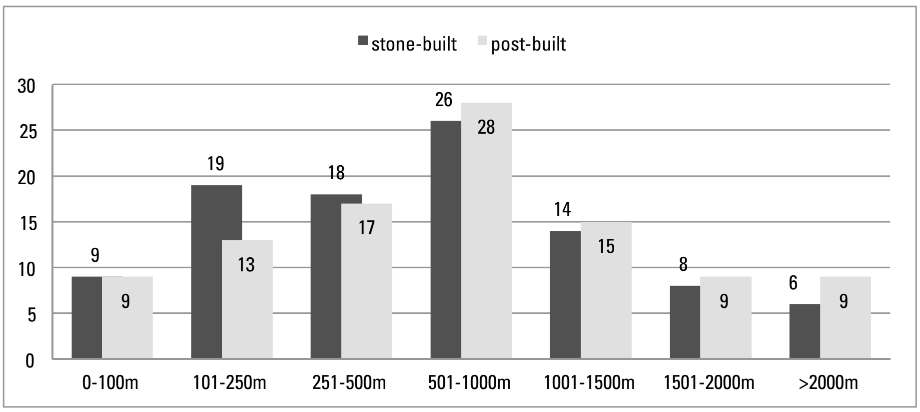


Chart 6.13 Proportions of settlements per distance-to-water zones, for the two types of rural settlement, using n=1944.

The Chi-squared calculation has the following results:

Distance zone	area (%)	n=1944 post-built expected	observed	χ2	n=1944 stone-built expected	observed	χ2
0-100m	12	51	40	**2.56**	149	111	**9.5**
101-250m	15	64	57	**0.84**	186	237	**14.17**
251-500m	20	86	74	**1.62**	248	223	**2.44**
501-1000m	24	103	120	**2.82**	297	324	**2.43**
1001-1500m	13	56	64	**1.21**	161	175	**1.23**
1501-2000m	7	30	38	**2.12**	87	100	**2.05**
>2000m	9	39	36	**0.18**	111	65	**16.92**
TOTAL	**100**	**429**	**429**	**11.35**	**1238**	**1238**	**48.75**

Tab. 6.32 Calculation of Chi-squared for the variable 'distance to water' per rural settlement type for the dataset n=1944.

N=1944	Post-built	Stone-built
Chi-square (Observed value)	11.35	48.75
Chi-square (Critical value)	10.6	22.5
D.F.	6	6
alpha	10	0.1

Tab. 6.33 Results of the Chi-squared calculation for the variable 'distance to water' per settlement type for the dataset n=1944.

The results of the Chi-squared calculation for n=1944 demonstrates that the values for both types are sufficient to reject the null-hypothesis; for post-built sites at the 10% level, for stone-built settlements at the 0.1 percentile. This means that a relation existed between both types of settlements and distance to water. Interestingly, the same trends per distance zone can be identified for the two types of settlement, as shown below; only the 100-250m zone shows a different preference.

Conclusion

It can be concluded from the above that distance to water seems to have been of influence on Roman settlement, with the zone of 500 – 2000 metres distance to water attracting the most settlement. However, in this case the outcome of the Chi-squared analysis for the post-built sites showed a different behavior for the two datasets n=1186 and n=1944.

Distance zone	Post-built settlements n=1186	Post-built settlements n=1944	Stone-built settlements n=1186	Stone-built settlements n=1944
0-100m	no influence	avoid	avoid	avoid
101-250m		avoid	prefer	prefer
251-500m		avoid	avoid	avoid
501-1000m		prefer	prefer	prefer
1001-1500m		prefer	prefer	prefer
1501-2000m		prefer	prefer	prefer
>2000m		avoid	avoid	avoid

Tab. 6.34 Preferences of the two rural settlement types in relation to the variable 'distance to water'.

6.1.3 ELEVATION, SLOPE, AND ASPECT

In this part the assumption is tested that elevation, and the related phenomena of slope and aspect, influenced Roman settlement. Lower areas are, for example, more prone to wetness, are expected to have been avoided, just like higher locations, that are usually more exposed to the elements. Areas with a pronounced relief are generally more difficult to work and more likely to suffer from soil erosion, and are therefore assumed to have been less densely populated than flatter areas.

The relief of the three modern-day countries differs greatly. It is the result of formative processes of more than two million years. One of the most important factors to have shaped the area was the tilting of the land between Meuse and Rhine from the southeast to the northwest, a result of the tectonic uplift of the Ardennes and Eifel region. This uplift caused a shift in the position of the main rivers, such as the Meuse, which resulted in the creation of terraces, still recognisable in the landscape today. Together with the down-cutting of the main rivers, smaller streams such as the Geul, Inde and Rur have also carved valleys into the plains.[24] During the different Ice Ages the environment was further transformed, and since the last Ice Age a combination of natural and human forces, such as precipitation, frost, heat, wind, flooding, deforestation and cultivation of land, have continued the alteration of the relief of the landscape. The landscape in the German Rhineland stands out for being almost flat, whereas the Dutch region has a pronounced relief with valleys and hills that are unlike the usual flatness associated with The Netherlands. The relief in Belgian Limburg is more pronounced than in Germany, but less than its Dutch counterpart. It should be emphasized, though, that for the majority of the region the relief is such that it hardly poses any serious challenge to farming activities, compared to truly mountainous areas. Also, almost all of the farming activities were done by hand in the Roman period, which means that slanted terrain, deemed unsuitable for cultivation today because of the use of tractors and other heavy machinery, would not be problematic for Roman farming. It is well-known that farmers in the past used techniques such as terracing to make a sloping terrain more suitable for farming.[25]

Aspect, or the position of a field in relation to the sun, is also assumed to have been an important factor. It was mentioned by Cato,[26] and locations with fields having the most favourable position to the sun (facing south/southeast/southwest) are expected to have been more densely populated, than those with fields in other positions.

As other authors have pointed out,[27] there is one important factor that has to be taken into account when using datasets for slope, aspect and elevation, especially in a loess-landscape. The datasets used represent the current situation and, due to the fact that loess soils are very prone to erosion, it can be assumed that the datasets are not completely accurate for the situation in the Roman period. In addition, the process of soil erosion and consequent deposition of colluvium is one of the most powerful depositional processes in the study area, and has certainly influenced site visibility. Settlements located at the foot of a slope of more than 8% have a much smaller chance of being detected than settlements on top of plateaus with a slope of 2% or less. Likewise, settlements located at the top of a slope might have eroded away completely over the past 2000 years. In other words, any relation found between settlements and slope could reflect the influence of soil erosion on site visibility, rather than an actual preference of Roman habitation. The same can be said for aspect, as slopes located on the east-south-east-south have always been favoured by farmers, and it can be argued therefore that ploughing is more likely to have happened on these slopes. This would result in a higher chance of being detected than slopes facing north, for example, that might be more likely to be covered in trees or used as pastures. This information has to be taken into account when interpreting the results of the following analyses.

[24] De Moor 2006, 26.

[25] Goodchild 2007, 127.

[26] Cato, De Agricultura.

[27] Goodchild 2007, 126.

Elevation

First we want to test if areas of a certain altitude were more densely populated than other areas. The elevation of the region, as indicated in chapter 2, varies greatly, with areas lying as low as 10 metres above sea level in the northwest, and as high as 300 metres in the vicinity of Aachen in the centre-south of the study region. However, large parts of the area lie at an altitude of between 50 and 150 metres, as can be seen below in figure 6.11. This map also shows the effects on the elevation landscape of the lignite mining in the German Rhineland, whereby the open air mines appear as large holes in the earth's surface, and the excavated spoil laid aside as artificial hills. To ensure reliable results, it was decided not to use any of the settlements located in the altered landscapes of the lignite mining areas in the analyses.

code	elevation	area (ha)	proportion
1	< 25 m	26,078	6%
2	25 - 50 m	82,183	19%
3	50 – 75 m	83,774	20%
4	75 – 100 m	99,074	23%
5	100 – 125 m	64,485	15%
6	125 – 150 m	31,421	7%
7	150 – 175 m	17,842	4%
8	175 – 200 m	11,306	3%
9	200 – 225 m	6,353	1%
10	> 225 m	6,557	2%

Tab. 6.35 Elevation classes used in this study, with corresponding area and proportion.

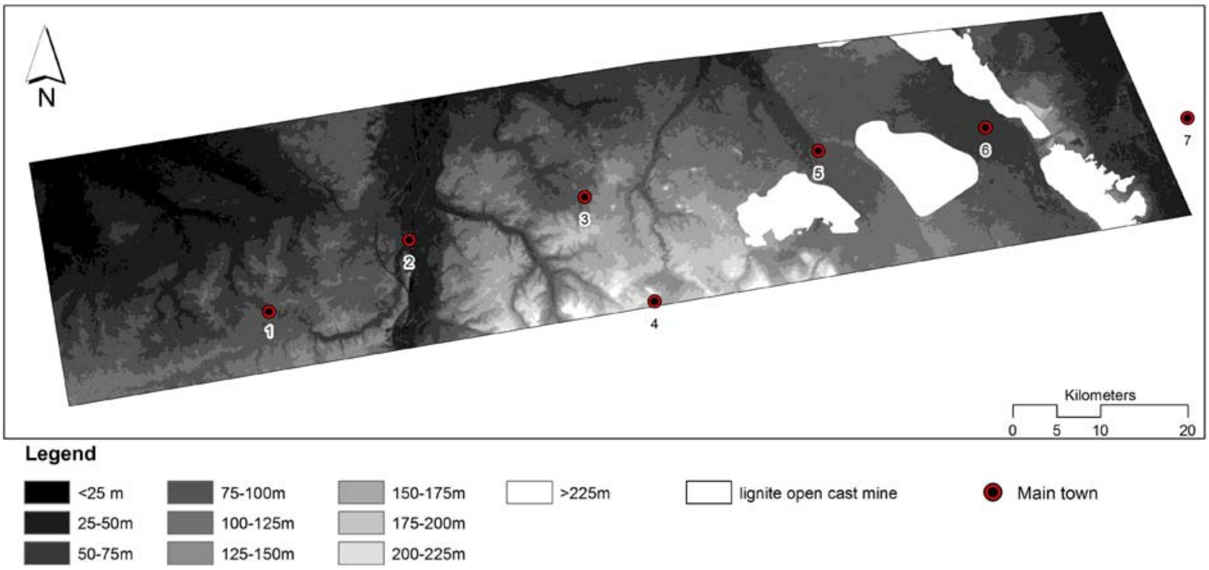


Fig. 6.11 Elevation map of the study area, with the three large open-cast mining areas of the German Rhineland in the eastern part of the study area.

A histogram of the variable 'elevation' was made for the two datasets n=1186 and n=1944. The first histogram, below, shows that the majority of settlements in the dataset n=1186 lies at an elevation of between 50 and 125 metres approximately. With elevations ranging from 26 to 207 metres, the mean value for this dataset is 93,9 metres.

The histogram for the dataset n=1944, below, demonstrates that it does not differ significantly from that of n=1186, with the majority of settlements located at approximately 50 to 125 metres. Elevation ranges from 11 to 259 metres above sea level, with a mean value of 92 metres.

To establish whether elevation influenced Roman settlement, the observed number of settlements per elevation class is compared to the expected number, based on the area of each elevation class.

elevation	area (%)	n=1186			n=1944		
		expected	observed	χ^2	expected	observed	χ^2
< 25 m	6	66	0	**66.36**	108	6	**96.69**
25 - 50 m	19	210	64	**101.63**	343	150	**108.71**
50 – 75 m	20	221	228	**0.21**	361	397	**3.55**
75 – 100 m	23	254	432	**124.02**	415	640	**121.47**
100 – 125 m	15	166	242	**34.91**	271	362	**30.64**
125 – 150 m	7	77	66	**1.68**	126	123	**0.09**
150 – 175 m	4	44	32	**3.39**	72	64	**0.94**
175 – 200 m	3	33	38	**0.70**	54	54	**0.00**
200 – 225 m	1	11	4	**4.51**	18	7	**6.77**
> 225 m	2	22	0	**522.12**	36	3	**30.37**
TOTAL	**100**	**1106**	**1106**	**359.53**	**1806**	**1806**	**399.23**

Tab. 6.36 Calculation of Chi-squared for the variable 'elevation' for the datasets n=1186 and n=1944.

	n=1186	n=1944
Chi-square (Observed value)	359.53	399.23
Chi-square (Critical value)	27.9	27.9
D.F.	9	9
alpha	0.1	0.1

Tab. 6.37 Results of the Chi-squared calculation for the variable 'elevation' for the datasets n=1186 and n=1944.

The evidence presented above confirms a relation between Roman settlement and elevation in the study area, whereby the land between 75 and 125, in particular 75 to 100 metres was significantly more densely populated. Land lower than 50 metres or higher than 200 metres seemed to have been unpopular.

The next assumption to be tested concerns the relation between elevation and the two main rural settlement types. It is emphasized here that those settlements without an accurate elevation value, due to their location in one of the lignite mines, were not included in the analysis.

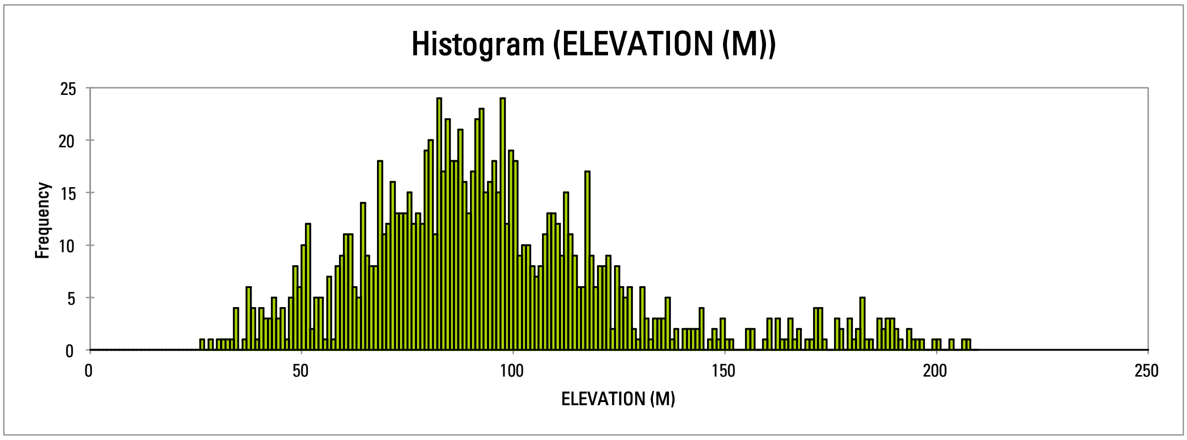


Chart 6.14 Histogram of the variable 'Elevation' for the dataset n=1186.

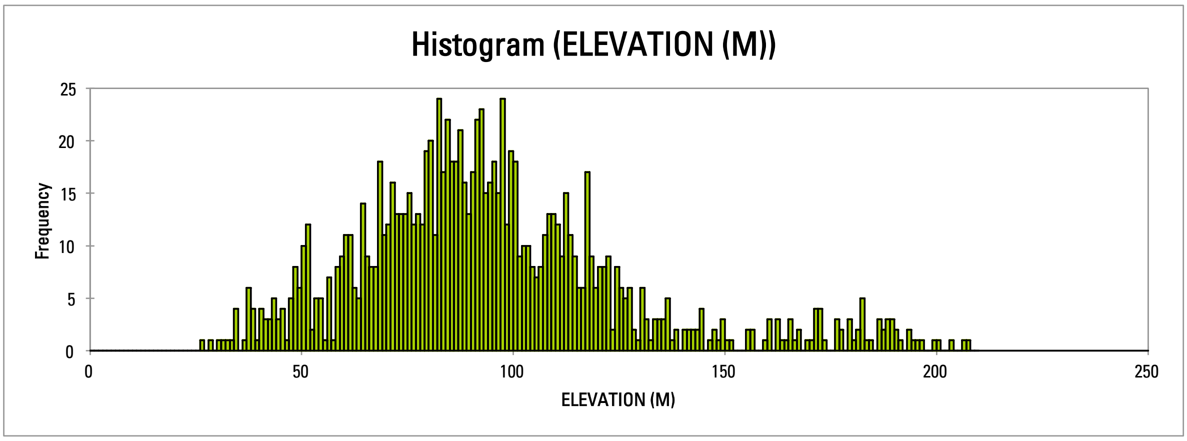


Chart 6.15 Histogram of the variable 'Elevation' for the dataset n=1944.

elevation	area (%)	n=1186 post-built		χ2	n=1944 post-built		χ2
		expected	observed		expected	observed	
< 25 m	6%	1	0	**1.02**	26	5	**16.71**
25 - 50 m	19%	3	3	**0.02**	82	3	**75.62**
50 – 75 m	20%	3	6	**1.99**	86	53	**12.54**
75 – 100 m	23%	4	3	**0.21**	99	97	**0.03**
100 – 125 m	15%	3	3	**0.08**	64	156	**130.53**
125 – 150 m	7%	1	2	**0.55**	30	56	**22.46**
150 – 175 m	4%	1	0	**0.68**	17	33	**14.62**
175 – 200 m	3%	1	0	**0.51**	13	18	**2.04**
200 – 225 m	1%	0	0	**0.17**	4	7	**1.71**
> 225 m	2%	0	0	**0.34**	9	1	**6.70**
TOTAL	**100**	**17**	**17**	**5.57**	**429**	**429**	**282.96**

Tab. 6.38 Calculation of Chi-squared for the variable 'elevation' for the post-built settlements.

Post-built settlements	n=1186	n=1944
Chi-square (Observed value)	5.57	282.96
Chi-square (Critical value)	14.7	27.9
D.F.	9	9
alpha	10	0.1

Tab. 6.39 Results of the Chi-squared calculation for the variable 'elevation' for the datasets n=1186 and n=1944.

For the post-built settlements the Chi-squared calculations were valid for both datasets (n=1186 and n=1944) because only two out of the 10 cells (= 20%) have an expected value < 1. However, the outcome for the two datasets differ, as the null-hypothesis of 'no relation' can be rejected for n=1944, but has to be accepted for n=1186. Influence of the factor elevation therefore cannot be proven for the post-built settlement sites in the most strict definition of this type (n=1186).

elevation	area (%)	n=1186 stone-built		χ2	n=1944 stone-built		χ2
		expected	observed		expected	observed	
< 25 m	6%	65	0	**64.50**	74	2	**70.33**
25 - 50 m	19%	204	61	**100.47**	235	77	**106.43**
50 – 75 m	20%	215	217	**0.02**	248	248	**0.00**
75 – 100 m	23%	247	424	**126.35**	285	528	**207.82**
100 – 125 m	15%	161	236	**34.65**	186	245	**18.94**
125 – 150 m	7%	75	64	**1.68**	87	61	**7.60**
150 – 175 m	4%	43	31	**3.35**	50	34	**4.86**
175 – 200 m	3%	32	38	**1.03**	37	40	**0.22**
200 – 225 m	1%	11	4	**4.24**	12	3	**7.11**
> 225 m	2%	22	0	**21.50**	25	0	**24.76**
TOTAL	**100**	**1075**	**1075**	**357.78**	**1238**	**1238**	**448.07**

Tab. 6.40 Calculation of Chi-squared for the variable 'elevation' for the stone-built settlements.

	n=1186	n=1944
Chi-square (Observed value)	357.78	448.07
Chi-square (Critical value)	27.9	27.9
D.F.	9	9
alpha	0.1	0.1

Tab. 6.41 Results of the Chi-squared calculation for the variable 'elevation' for the stone-built settlements.

For the stone-built settlements the values of Chi-squared for both datasets confirm a significant relation between elevation and settlement. The results for both types and both datasets are then compared to determine possible differences in elevation preference between the two settlement types. These results are shown in table 6.42.

Elevation zone	Post-built		Stone-built	
	n=1186	n=1944	n=1186	n=1944
< 25 m	no relation	avoid	avoid	avoid
25 - 50 m		avoid	avoid	avoid
50 – 75 m		avoid	neutral	neutral
75 – 100 m		neutral	prefer	prefer
100 – 125 m		prefer	prefer	prefer
125 – 150 m		prefer	avoid	avoid
150 – 175 m		prefer	avoid	avoid
175 – 200 m		prefer	neutral	neutral
200 – 225 m		prefer	avoid	avoid
> 225 m		avoid	avoid	avoid

Tab. 6.42 Preferences of the two rural settlement types in relation to the variable 'Elevation'.

Based on the results in table 6.42, it can be concluded that both types of settlement avoided land lower than 50 metres and higher than 225 metres, and that an altitude of between 100 and 125 metres seemed to have been the most popular elevation zone. Interestingly, post-built settlements do not seem to have been found at an altitude between 75 and 100 metres, whereas many stone-built settlements were found here. On the other hand, stone-built settlements were rarely found at an elevation higher than 125 metres, with the exception of the zone of 175 to 200 metres, whereas post-built settlements

Fig. 6.12a and b. Slope raster images of area near Gulpen (at the heart of Dutch South Limburg) at a scale of 1:50.000.The map above (a) is based on the Aster-DEM data; the map below (b) on the AHN DEM data.

seemed to be more common on these higher altitudes. All of the above can be interpreted as evidence for the assumption that elevation was of influence on Roman rural settlement, and that post-built and stone-built settlements demonstrate diverging behavior.

Slope
For the factor 'slope', the assumption to be tested is whether flatter areas were more densely populated than steeper areas. With regards to the types of rural settlement, it will be examined whether stone-built settlements occupied different locations than post-built settlements.

As the slope differences are strongest in current-day Dutch Limburg, it can be argued that here, more than in the other regions, the slope of a particular location would have influenced Roman settlement. In addition to this, the digital elevation model made using the Aster data, with a raster size of 20 by 30 metres, was deemed too coarse to produce reliable results for this factor. The *AHN* DEM for the Dutch part of the study region is much more precise with a raster size of 5x5 metres (see figure 6.12, below, for a comparison of the two datasets) and therefore it was decided to only analyse the settlement patterns in Dutch Limburg regarding the factors of 'slope' and 'aspect'.

The slope percentages in this part of the study area range from 0 to a maximum of 70.77%, with a mean value of 3.3%. For practical reasons, the slope variable was reclassified into four categories, and the resulting areas per slope class, presented below, demonstrate that nearly half of the entire area consists of land with a slope lower than 2%, whereas the steep slopes of over 8% constitute only 9%.

slope %	class no.	area (ha)	area (%)
0-1.99	1	25,389	44
2-3.99	2	15,829	27
4-7.99	3	11,546	20
>8	4	5,256	9

Tab. 6.43 Four categories used to classify the slope dataset, with corresponding areas and proportions, in Dutch Limburg.

Figure 6.13 shows that the majority of slope class 4 is located in the centre-southern part of the region. The Meuse and Geul valley floor fall in category 1, as well as large parts of the plateaus north and south of the Geul.

Of the 161 settlements in dataset n=1186 on Dutch territory, the majority have a slope percentage of less than 8%. The minimum value is 0.035, the maximum is 17.051, the mean value being 2.734.

Using the four slope categories the expected frequencies can be calculated, which are then used to calculate Chi-square. The 161 settlements in the Dutch part of the dataset n=1186 provide the following result:

Slope category	Area (%)	N=1186 – settlements NL (161)		$\chi 2$
		expected	observed	
0 – 1.99%	44	71	72	**0.02**
2 – 3.99%	27	43	56	**3.61**
4 – 7.99%	20	32	28	**0.55**
> 8%	9	14	5	**6.22**
TOTAL	100	161	161	**10.39**

Tab. 6.44 Calculation of Chi-square for the Dutch part of the dataset n=1186, for the variable 'slope'.

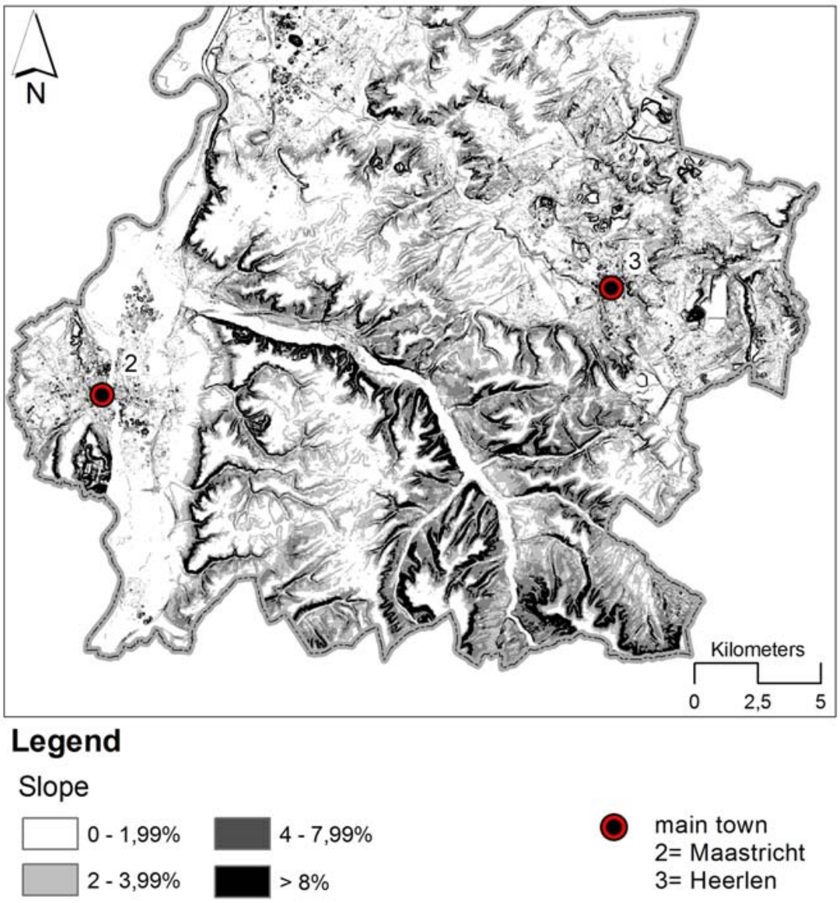


Fig. 6.13 Map of Dutch Limburg showing the distribution of the four classes of slope used in this study.

Using the dataset n=1944, it is clear that, although more settlements appear with higher values, the majority still have a value in the lower range (less than 8). The minimum value is 0.035, the maximum 17.05, the mean value being 2.862.

Slope category	Area (%)	N=1944 – settlements NL (375)		χ^2
		expected	observed	
0 – 1.99%	44	165	176	**0.73**
2 – 3.99%	27	101	115	**1.87**
4 – 7.99%	20	75	67	**0.85**
> 8%	9	34	17	**8.31**
TOTAL	**100**	**375**	**375**	**11.77**

Tab. 6.45 Calculation of Chi-square for the Dutch part of the dataset n=1944, for the variable 'slope'.

The observed Chi-squared values for both datasets are then compared to the critical values to see whether a statistically significant relation can be established.

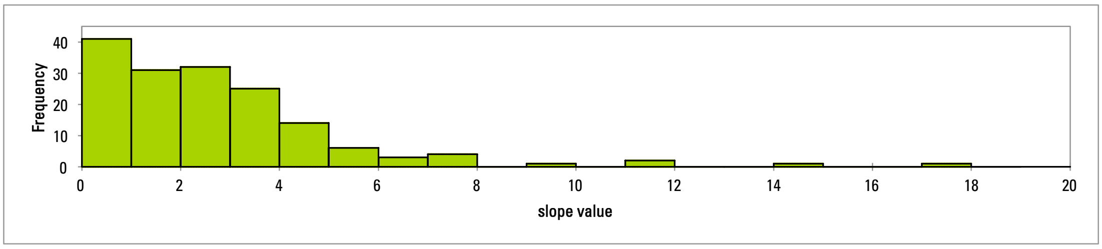


Chart 6.16 Histogram of the Dutch part of the dataset n=1186, for the variable ‘slope’ (x = slope in %).

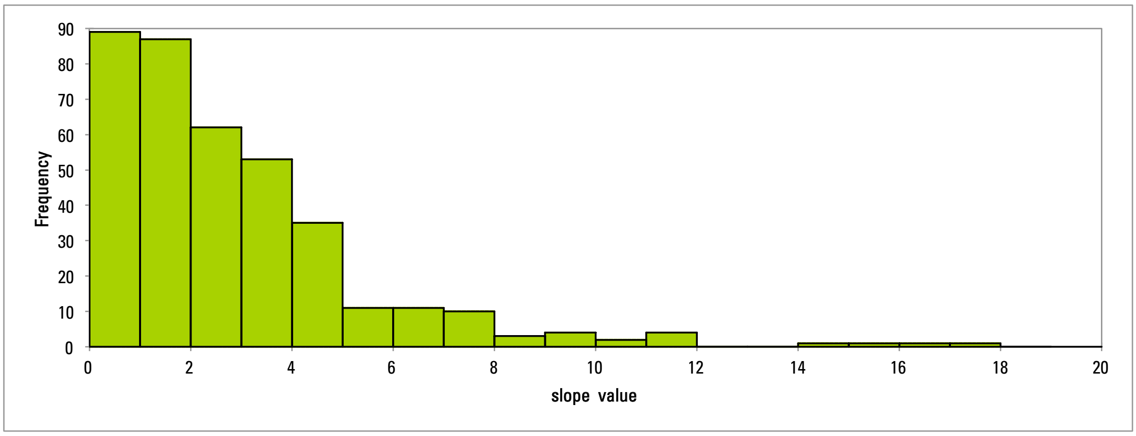


Chart 6.17 Histogram of the Dutch part of the dataset n=1944, for the variable ‘slope’. (x= slope in %,)

	N=1186	N=1944
Chi-square (Observed value)	10.39	11.77
Chi-square (Critical value)	7.81	11.3
D.F.	3	3
alpha	5	1

Tab. 6.46 Results of the Chi-squared calculation for the variable ‘slope’ for the datasets n=1186 and n=1944.

The results of the Chi-squared calculations indicate that for both datasets the null-hypothesis can be rejected. This means that there was a relation between Roman rural settlement and the factor slope. For the dataset n=1186 this can be done with 95% certainty; for n=1944 this is 99%. According to the outcome of the analysis, significantly more settlements were found at locations with shallower slopes. The individual Chi-square values per cell provide important clues to the overall reliability of the observations. For both datasets it can be concluded that for the categories <8% slope the observed number of settlements is only slightly above the expected value, with low Chi-square values as a result. In fact the overall Chi-square value is raised significantly by the high value for the category of >8%, and the difference between the expected and observed number of settlements here is evidence that few settlements are found in this slope category. However, this result can also be seen as evidence of the effect of soil erosion, whereby archaeological remains are either obliterated by erosion or covered by colluvium, rather than a ‘real’ preference for settlement in flatter areas. If Roman farmers really did prefer flatter locations, the question remains why the observed number of settlements in these categories is only slightly higher than expected.

Closer inspection of the map depicting the different slope categories indicates that there might even be another explanation for the perceived relation between slope and settlement. In figure 6.14, the

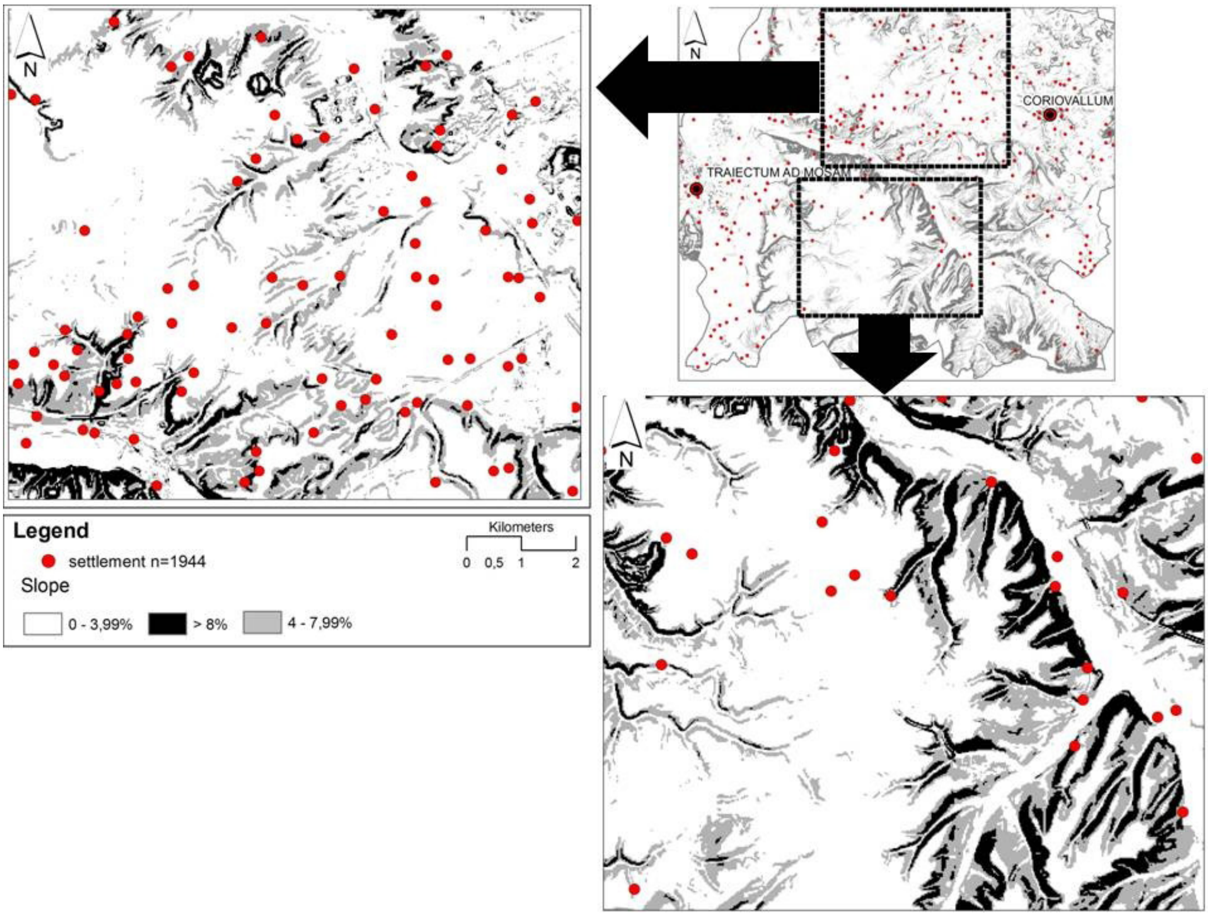


Fig. 6.14 Distribution of settlements on the slope map of Dutch Limburg, showing the difference between settlement patterns in two micro-regions, with regards to density of settlement on slopes <4%.

settlements, shown as dark dots, are seen against the background of the slope dataset, whereby white areas represent slopes of 4% or less, grey slopes between 4 and 8%, and black slopes over 8%. The first thing that catches the eye is that the southern area is much less densely populated than the northern area, lying to the west of Coriovallum, even though there seems to be the same amount of flat land. Closer inspection of the micro-region west of Coriovallum shows that, even within this area, there are differences in site density, with a noticeable gap in the flat area in the west. This map can be considered evidence that, even though there is a statistically significant relation between slope and settlement, it does not translate into a dense habitation of all land with a slope of less than 4%. In view of the impact of the variety in archaeological practices in the study area (see part 5.4.3 in the previous chapter) the observed pattern could also reflect the results of specific focus on the slopes for part of the region, rather than an actual settlement pattern.

Another observation concerns the location of the settlements themselves. Rather than an even distribution throughout the (flattest) land, settlements seemed to be clustered on the edges of plateaus, right at the edge, or at the top of small valleys leading from the plateaus into the lower-lying areas. This pattern, which can also be observed in other parts of the study area, for example in the *Weisweiler* lignite mining region, points to what has not yet been addressed here: the difference between location of arable fields and actual dwellings. The settlement dataset uses the point location of the built area of a rural settlement, and therefore when analyzing the possible relation between slope and settlement, it is the dwelling that is related to slope, not the cultivated fields. The observed settlement pattern in the two examples below hint at the possibility that in examining slope in relation to the settlement dataset, we might be 'barking up the wrong tree', as it tells us nothing about the preference of locating the actual cultivated fields on flat land. To do so the settlement data would have to be used to recreate territories, which could then be related to slope. This would involve a considerable amount of additional research and reconstructions, and it was decided not to pursue this line of inquiry any further in this study, but it would make for an interesting topic for future research.

Next the possible relation between slope and settlement type was examined using the sample of settlements in Dutch Limburg. First the dataset n=1186 was analysed.

Type/ slope class	**0-1,99%**	**2-3,99%**	**4-7,99%**	**>8%**	**total**
Post-built	3	3	1	0	7
Stone-built	68	52	26	5	151
TOTAL	**71**	**55**	**27**	**5**	**158**

Tab. 6.47 Contingency table for the dataset n=1186 in Dutch Limburg, for the variable 'slope'.

Slope class	**area (%)**	**post-built (n=7)**		χ^2	**stone-built (n=151)**		χ^2
		expected	**observed**		**expected**	**observed**	
0 – 1.99%	44	3	3	**0.00**	66	68	**0.04**
2 – 3.99%	27	2	3	**0.65**	41	52	**3.09**
4 – 7.99%	20	1	1	**0.11**	30	26	**0.58**
> 8%	9	1	0	**0.63**	14	5	**5.43**
TOTAL	**100**	**7**	**7**	**1.40**	**151**	**151**	**9.14**

Tab. 6.48 Calculation of Chi-squared for the variable 'slope' for the two types of rural settlement in Dutch Limburg using n=1186.

N=1186	**Post-built**	**Stone-built**
Chi-square (Observed value)	1.40	9.14
Chi-square (Critical value)	6.25	7.81
D.F.	3	3
alpha	10%	5%

Tab. 6.49 Results of the Chi-squared calculation for the variable 'slope', for type of settlement in Dutch Limburg using n=1186.

Using the n=1186 dataset, the analysis shows that the null-hypothesis can be rejected for the stone-built sites, thus attesting a relation between slope and this type of settlement. However, for post-built settlements the null-hypothesis cannot be rejected, as even with alpha = 10% the observed Chi-square value is lower than the critical value. A relation between post-built farms and slope therefore cannot be proven. Nevertheless, the few post-built sites in this dataset were located on the flatter areas, and absent from the steeper land. This is the same 'behaviour' as the stone-built sites.

Next the relation between slope and type of settlement will be tested using the n=1944 dataset.

Type/ slope class	1	2	3	4	Total
Post-built	67	37	17	6	127
Stone-built	74	55	31	5	165
TOTAL	**141**	**92**	**48**	**11**	**292**

Tab. 6.50 Contingency table for the dataset n=1944 in Dutch Limburg, for the variable 'slope'.

Slope class	area (%)	post-built (n=127)		χ^2	stone-built (n=165)		χ^2
		expected	observed		expected	observed	
0 – 1.99%	44	56	67	**2.21**	73	74	**0.03**
2 - 3.99%	27	34	37	**0.21**	45	55	**2.45**
4 - 7.99%	20	25	17	**2.78**	33	31	**0.12**
> 8%	9	11	6	**2.58**	15	5	**6.53**
TOTAL	**100**	**127**	**127**	**7.78**	**165**	**165**	**9.13**

Tab. 6.51 Calculation of Chi-squared for the variable 'slope' for the two types of rural settlement in Dutch Limburg for n=1944.

N=1944	Post-built	Stone-built
Chi-square (Observed value)	7.78	9.13
Chi-square (Critical value)	6.25	7.81
D.F.	3	3
alpha	10%	5%

Tab. 6.52 Results of the Chi-squared calculation for the variable 'slope', for type of settlement in Dutch Limburg for n=1944.

The results of the Chi-squared calculations for the dataset n=1944 allow for the rejection of the null-hypotheses for both settlement types: at the 5% level for the stone-built, and at the 10% for the post-built type. As with the n=1186 dataset, the flatter areas are favoured over the steeper areas (with a slope of over 4%). Interestingly though, settlements were found in all slope categories. This means that overall, steep slopes did not prevent settlement in the Roman period.

In order to establish whether the two types of rural settlement have different preferences regarding slope, their 'results' are compared. The results in table 6.53, below, indicate that post-built settlements were more likely to be found on flat lands, whereas stone-built were more likely to be located on slightly sloping land; both types appear to have avoided all lands steeper than 4%. It must be reiterated here that these patterns may reflect the results of 2000 years of soil erosion, whereby steeper slopes will have suffered more than flatter areas.

slope	Post-built		Stone-built	
	n=1186	n=1944	n=1186	n=1944
0 – 1.99%	no relation	prefer	neutral	neutral
2 – 3.99%		neutral	prefer	prefer
4 – 7.99%		avoid	neutral	neutral
> 8%		avoid	avoid	avoid

Tab. 6.53 Preferences of the two rural settlement types in relation to the variable 'slope', for Dutch Limburg.

Aspect

Aspect is the last element of the physical environment that will be analysed for its presumed influence on Roman settlement. The assumption is that significantly more settlements were located on slopes that are south, southeast or southwest facing, compared to the other directions. The first step in the analysis is to visualise the aspect of the slopes across the study area, using a digital elevation model (DEM). The results for the study area are shown below, where all slopes facing either south, southeast or southwest are depicted in white, and all other slopes in black.

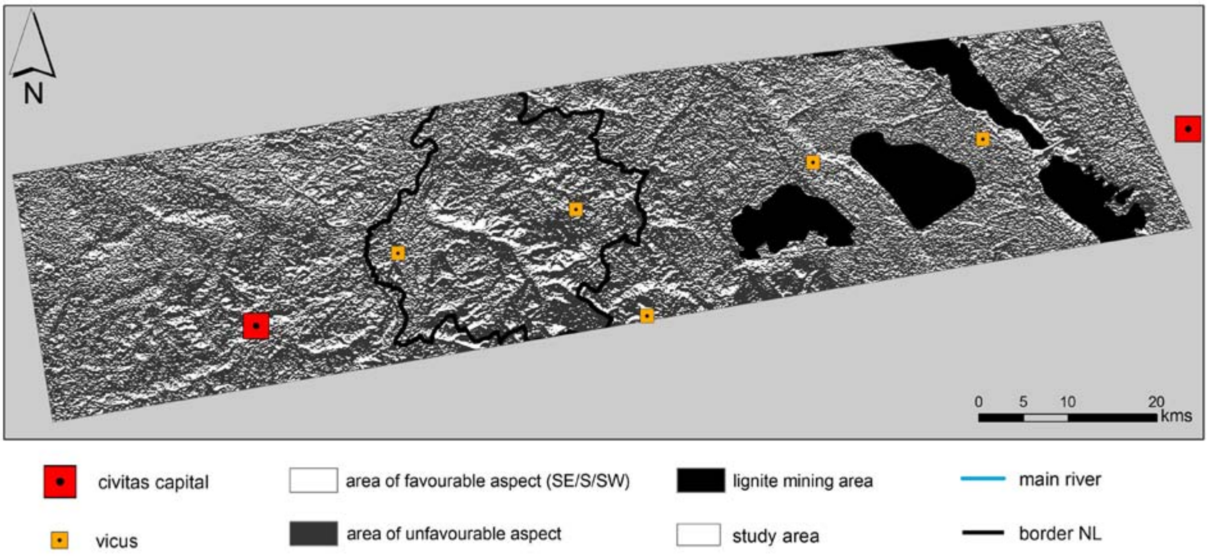


Fig. 6.15 Map of the study area showing the distribution of south/southeast/southwest facing slopes and all other slopes.

Starting with the area per aspect category, below in table 6.54, it can be established that the supposedly favored aspect category of southern, southeastern and southwestern slopes are in fact slightly less in proportion to the other aspect slopes. Together they form 1/3 of the total area.

aspect	area (ha)	%
N	60,837	15
NE	55,191	14
E	50,711	13
SE	44,982	11
S	43,731	11
SW	46,347	11
W	50,514	12
NW	54,670	13

Tab. 6.54 Area per aspect and the resultant percentages.

Next the number of settlements per aspect category is determined, for both datasets, with the following results.

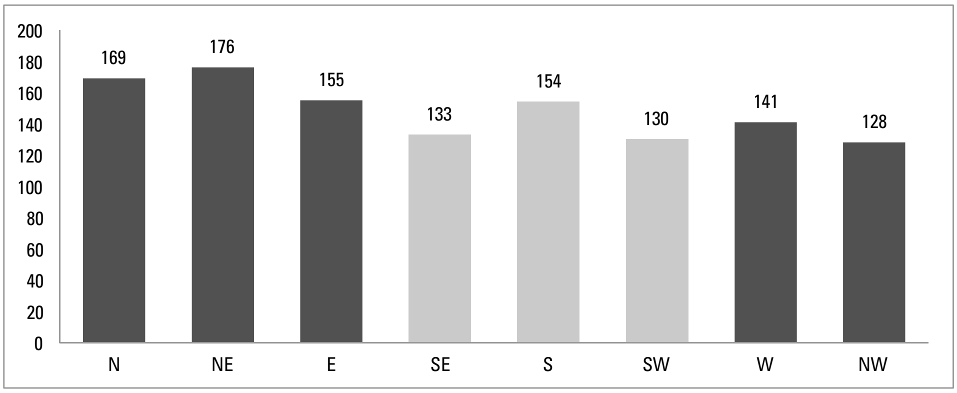


Chart 6.18 Distribution of settlements over the eight aspect categories for n=1186. The light-grey columns represent the supposedly favoured slopes.

Chart 6.19 Distribution of settlements over the eight aspect categories for n=1944. The light-grey columns represent the supposedly favoured slopes.

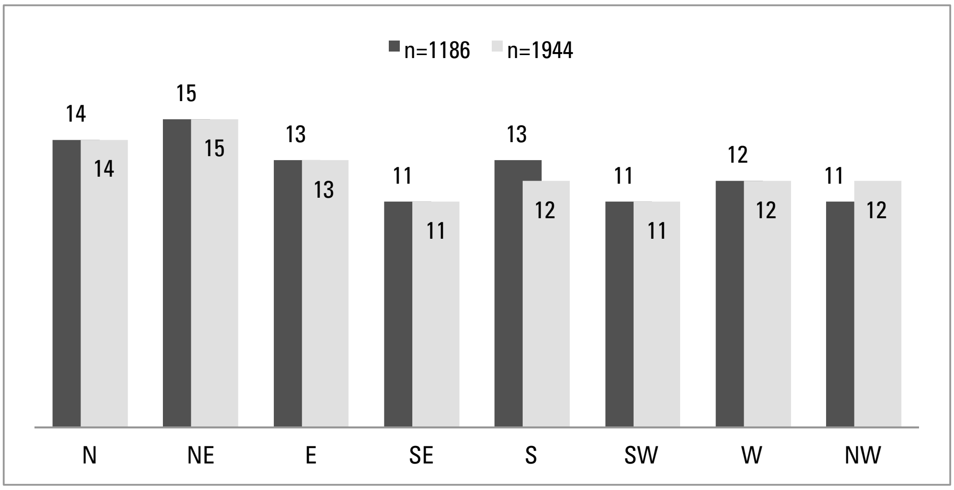


Chart 6.20 Comparison of the proportions per aspect category for the two datasets n=1186 and n=1944.

Comparison of the proportions per aspect category for each of the two datasets shows that there is a remarkable similarity between the two.

With the observed values and area per aspect category, the Chi-squared values are calculated for both datasets, with the following results:

aspect	area (%)	n=1186 expected	observed	χ^2	n=1944 expected	observed	χ^2
N	15	178	169	**0.45**	292	280	**0.46**
NE	14	166	176	**0.60**	272	282	**0.36**
E	13	154	155	**0.00**	253	252	**0.00**
SE	11	130	133	**0.05**	214	212	**0.02**
S	11	130	154	**4.25**	214	235	**2.09**
SW	11	130	130	**0.00**	214	214	**0.00**
W	12	142	141	**0.01**	233	234	**0.00**
NW	13	154	128	**4.45**	253	235	**1.24**
TOTAL	**100**	**1186**	**1186**	**9.80**	**1944**	**1944**	**4.17**

Tab. 6.55 Calculation of Chi-squared for the variable 'aspect' for the datasets n=1186 and n=1944.

	N=1186	N=1944
Chi-square (Observed value)	9.80	4.17
Chi-square (Critical value)	12.0	12.0
D.F.	7	7
alpha	10%	10%

Tab. 6.56 Results of the Chi-squared calculation for the variable 'aspect' for the datasets n=1186 and n=1944.

Table 6.56 shows that for both datasets the observed Chi-squared values are not high enough to reject the null-hypothesis. Therefore it must be established that there was no relation between Roman settlement and aspect in the study area.

There could be a possible explanation for this observed independence. Upon close inspection of the map it is possible to establish a significant difference between particular parts of the study area. In Dutch Limburg, where the relief is more pronounced than in the other regions, the areas of a particular aspect are larger in size than elsewhere, whilst in the Rhineland, the areas with a particular aspect are much smaller in size. Figure 6.16 illustrates this. An area of 1 km2 is shown in the German Rhineland on the left, and in Dutch Limburg on the right. The dark cells indicate areas with favourable aspect (SE/S/SW). Clearly the factor aspect is more pronounced in Dutch Limburg.

It is not difficult to imagine that, in a flatter landscape, aspect has less impact than in a region with more pronounced relief. In the former it is safe to say that even a north-facing slope receives a fair amount of the sun's rays, due to the small differences in elevation. A north-facing slope in a landscape of greater relief, however, stands a good chance of not getting any sunshine at all. It can therefore be argued that, in flatter areas, aspect might not have been an influential settlement factor, but that it must have been influential in areas of greater relief. The Chi-squared values determined earlier reflected the overall situation of the study area, including the flatter areas. In light of this, it was decided to test the dataset for aspect using two micro-regions in Dutch Limburg with a pronounced relief. As with the variable 'slope', it was believed that if 'aspect' was of influence on settlement, it must be visible here.

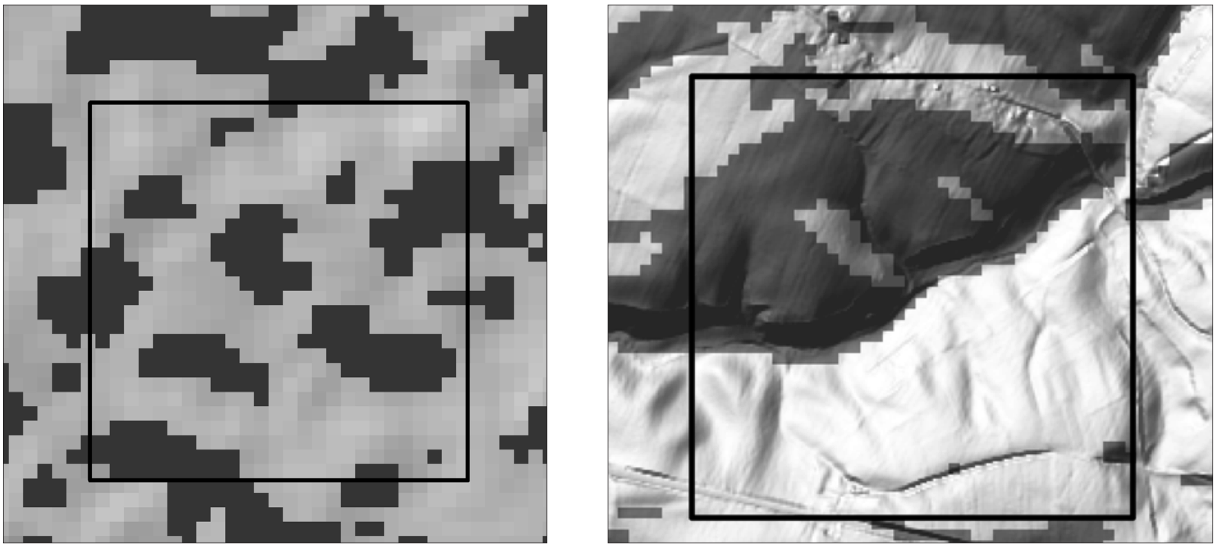


Fig. 6.16a and b. Comparison of aspect in the Rhineland, left (a), to aspect in Dutch Limburg, right (b). The square is an area of 1 km2. The dark cells indicate areas of favourable aspect (SE/S/SW).

Because of the fact that the sample for each of the two datasets in these micro-regions is small, which increases the risk of rendering the Chi-square calculation non-valid, it was decided to test whether settlements fell in either one of two categories, the first having S, SE and SW slopes, and the other with N, NE, E, W and NW slopes. The area per aspect category was calculated for each of the two micro-regions. It is interesting to note that in micro-region 1 the area for the 'sunny' slopes is higher than in micro-region 2.

aspect	Micro-region1 area (ha)	%	Micro-region 2 area (ha)	%
N, NE, E, W, NW	6,860	67	13,547	72
S, SE, SW	3,391	33	5,250	28
TOTAL	**10,251**	**100**	**54,670**	**100**

Tab. 6.57 Area per aspect category and the resultant percentages for the two micro-regions.

Micro-region 1 aspect	area (%)	n=1186 (39)		χ^2	n=1944 (75)		χ^2
		expected	observed		expected	observed	
S / SE / SW	33	13	10	**0.64**	25	28	**0.43**
OTHER	67	26	29	**0.32**	50	47	**0.21**
TOTAL	**100**	**39**	**39**	**0.96**	**75**	**75**	**0.64**

Tab. 6.58. Calculation of Chi-squared for the variable 'aspect' for settlements in micro-region 1.

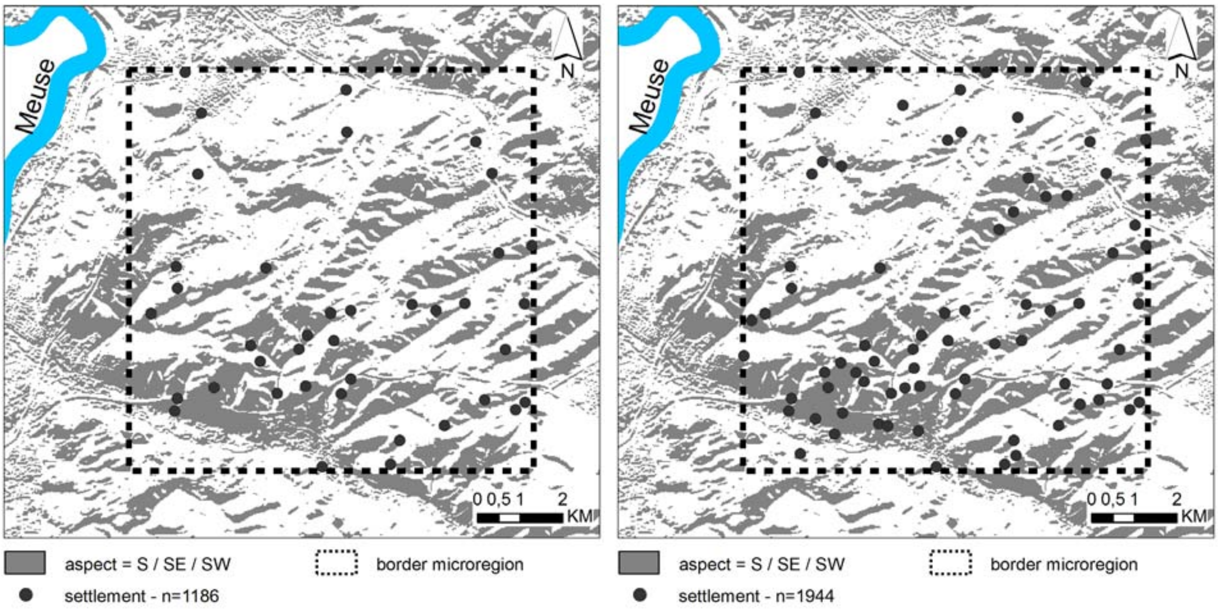


Fig. 6.17a and b. Distribution of settlements in micro-region 1 for the variable 'aspect', for the datasets n=1186 (a, left) and n=1944 (b, right).

MICRO-REGION 1	N=1186	N=1944
Chi-square (Observed value)	0.96	0.64
Chi-square (Critical value)	2.71	2.71
D.F.	1	1
alpha	10%	10%

Tab. 6.59 Results of the Chi-squared calculation for the variable 'aspect' for settlements in micro-region 1.

Based on the results of the Chi-squared calculations it can be concluded that there was no relation between Roman settlement and the variable 'aspect' in micro-region 1 in Dutch Limburg. The assumed preference of Roman farmers for sunny slopes cannot be attested here. As with the variable 'slope', it can be argued that the analysis above is not valid as it tests the location of the main dwelling rather than the location of the fields. This could be an explanation for the observed lack of relation between settlement and aspect. However, as this study does not attempt to reconstruct territories, this line of inquiry cannot be pursued here, but it is certainly a topic worthy of further investigation.

For completeness sake, the dataset n=1944 for micro-region 1 was used to see whether there was a difference in 'behaviour' between the two types of rural settlements with regards to aspect. The distribution of settlements over the eight categories was as follows:

Type/aspect	N	NE	E	SE	S	SW	W	NW	Total
Post-built	5	3	5	3	2	2	3	1	24
Stone-built	9	5	5	6	4	0	4	5	38
Total	**14**	**8**	**10**	**9**	**6**	**2**	**7**	**6**	**62**

Tab. 6.60 Contingency table for the dataset n=1944 in micro-region 1, for the variable 'aspect'.

Micro-region 1 aspect	area (%)	stone-built (38)		χ^2	post-built (24)		χ^2
		expected	observed		expected	observed	
S / SE / SW	33	13	10	**0,51**	8	7	**0,11**
OTHER	67	25	28	**0,25**	16	17	**0,05**
TOTAL	**100**	**38**	**38**	**0,77**	**24**	**24**	**0,16**

Tab. 6.61 Calculation of Chi-squared for the variable 'aspect' for settlements in micro-region 1.

MICRO-REGION 1	Stone-built	Post-built
Chi-square (Observed value)	0,77	0,64
Chi-square (Critical value)	2,71	2,71
D.F.	1	1
alpha	10%	10%

Tab. 6.62 Results of the Chi-squared calculation for the variable 'aspect' for the two types of rural settlement in micro-region 1.

The observed Chi-squared values indicate that for neither of the settlement types a relation exists with the variable of aspect. The assumed relation between stone-built and a location on a south, southeast or southwest facing slope cannot be proven in this micro-region, as inspection of the individual cells shows that there are in fact less stone-built than expected on these slopes, and more stone-built than expected on the other slopes. The distribution of post-built settlements is in line with the expectations based on the area.

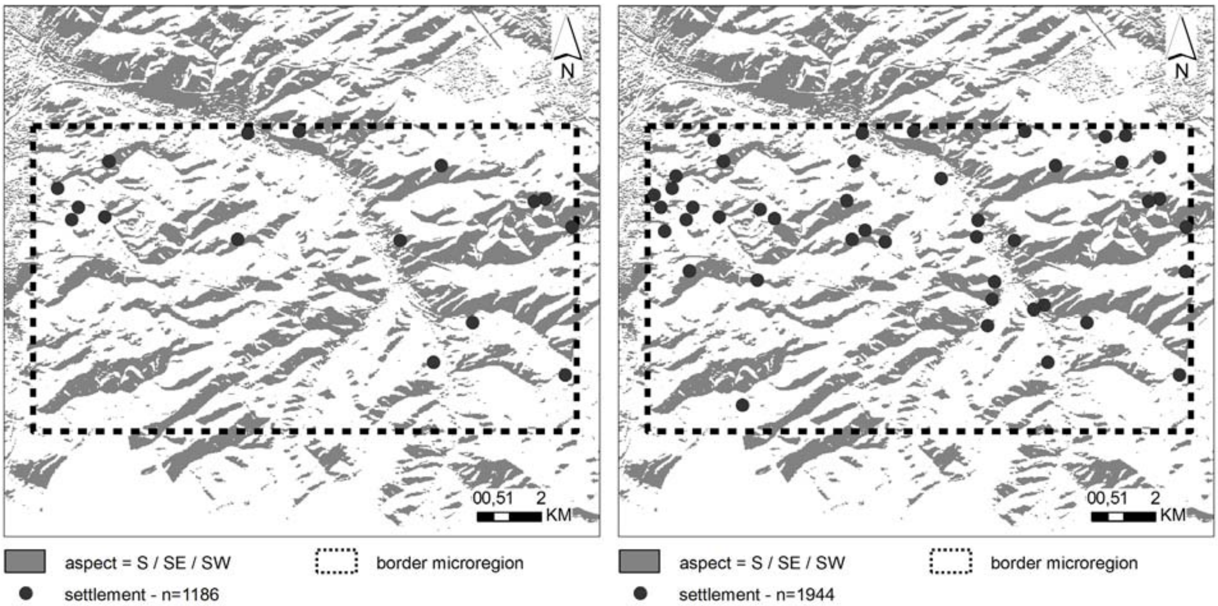


Fig. 6.18a and b. Distribution of settlements in micro-region 2 for the variable 'aspect', using the datasets n=1186 (a, left) and n=1944 (b, right).

Micro-region 2 aspect	area (%)	n=1186 expected	observed	χ^2	n=1944 expected	observed	χ^2
S / SE / SW	28	4	5	**0.06**	12	10	**0.44**
OTHER	72	12	11	**0.02**	32	34	**0.17**
TOTAL	**100**	**16**	**16**	**0.08**	**44**	**44**	**0.61**

Tab. 6.63 Calculation of Chi-squared for the variable 'aspect' for settlements in micro-region 2.

MICRO-REGION 2	N=1186	N=1944
Chi-square (Observed value)	0.08	0.61
Chi-square (Critical value)	2.71	2.71
D.F.	1	1
alpha	10%	10%

Tab. 6.64 Results of the Chi-squared calculation for the variable 'aspect' for the two settlement datasets in micro-region 2.

The results presented above show that for micro-region 2 a relationship between settlement and aspect also could not be proven. It has to be concluded that aspect was not a factor that influenced settlement in the study area.

6.1.4 settlements and the physical environment: conclusions

Now that the five elements of the physical environment, soils, water, elevation, slope and aspect have been analysed, the results can be compared. At the beginning of this chapter it was assumed that five elements of the physical environment of the study area might have influenced Roman settlement: soil type, distance to water, elevation, slope and aspect. For four of these five elements, a relation with Roman settlement in the study area was proven: soil type, distance to water, elevation, and slope. Significantly more settlements than expected were found in areas with specific environmental conditions, such as:

Soil type: loess soils (in Belgian and Dutch Limburg) and *Gley* soils (in the Rhineland);

Distance to water: 100 to 250 metres, and 500 to 2000 metres;

Elevation: 75 to 125 metres altitude;

Slope: 2 to 3,99% (in Dutch Limburg).

The only variable for which a relation with Roman settlement could not be proven, was aspect.
Interestingly, the assumptions regarding different preferences for the two main types of rural settlement were not always proven by the Chi-squared analyses. For example, both types of sites were found in abundance on the more fertile soils and seemed to have avoided the more marginal soil types. The only problem with these analyses was that when the dataset n=1186 was used, because of the low number of post-built sites often the calculations could not be performed. Nevertheless, the evidence was such that the assumptions regarding different settlement strategies for post-built and stone-built farms could not be clearly attested.

Performing the different analyses for single variables, the question arises what is being tested exactly. It is hardly likely that one single variable is responsible for settlement behavior; it seems more probable that a combination of variables influences settlement. In order to assess the relative influence of more factors, additional analyses have to be performed. This will be done in the third part of this chapter (6.3). But first two additional factors, will be analysed that are supposed to have influenced settlement. These factors are of a different nature than those examined until now. They concern the socio-economic situation of the new Roman province, in particular the two new elements introduced to the region by the Romans: the towns and the main roads.

6.2 SETTLEMENT PATTERNS AND THE SOCIO-ECONOMIC ENVIRONMENT

The implantation of towns as socio-political and economic centres, and the construction of main roads connecting these towns and the region with other parts of the empire, is thought to have created a completely new situation in the region, compared to the late Iron Age. Assessing the influence of these new towns and roads can help to provide answers regarding the question of continuity between late Iron Age and Roman settlement patterns. If it can be proven that rural settlement distribution was influenced by the new towns and roads, this could be seen as evidence of a break with the late Iron Age tradition, in which no centres or roads were present.

In addition to the general trend, the development of the rural settlement landscape will be examined in relation to the towns and roads. It can be argued that the attraction of the new phenomena increased over the years as their significance as centres of trade and political activity increased. This would mean that their influence on rural settlement changed over the centuries.

The type of rural settlement in relation to the distance to town and road will also be analysed. If it is assumed that stone-built settlements were involved in a system of interregional trade, a strong relation should be expected for this type of settlement and both the main roads and the towns, where the main activity of this trade took place. Post-built settlements are expected to be less dependent, or even independent, when it is assumed that they were not (as) involved in this part of the provincial-Roman economy.

6.2.1 DISTANCE TO A TOWN

In order to create the 'Distance-to-a-town' variable for each settlement site, buffer zones were created around each main town in the study area. Smaller urban centres, such as the roadside villages at Rimburg and Elsdorf, were not taken into account; however, towns located just outside of the study area were included, such as *Colonia Claudia Ara Agrippinensium*, and the *vicus* at current-day Gangelt in Germany, located to the northwest of Heerlen.

Next the region was divided into 5 distance zones, as shown in figure 6.19, and table 6.65, below. Table 6.65 shows that almost 90% of the region lay within 10 *leugae* (15 kilometres) of a Roman town. Generally speaking this means that from almost anywhere in the region a town could be reached easily within a day.

Distance to the nearest town	area (ha)	area (%)
<5 km	46,425	14
5-10 km	134,530	41
10-15 km	109,283	34
15-20 km	29,211	9
>20 km	5,374	2

Tab. 6.65 Distance-to-town zones plus their areas and respective proportions.

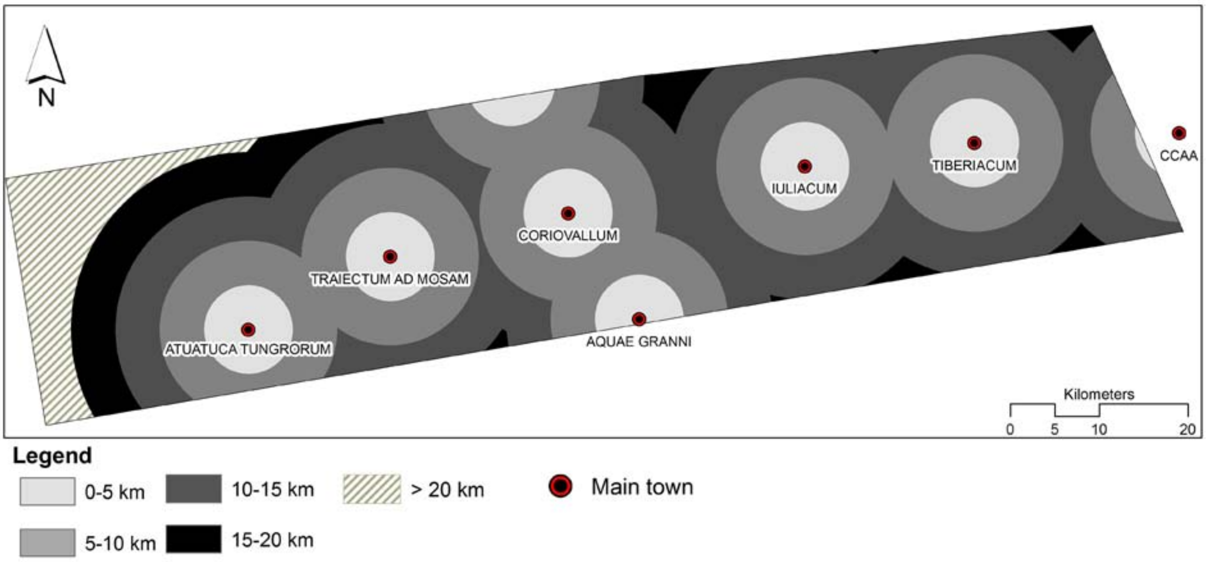


Fig. 6.19 Location of the main towns and their buffer zones. The vicus located near the modern-day town of Gangelt, Germany, is located just outside of the study area, northwest of Coriovallum.

After obtaining the 'distance to nearest town' value for each settlement site in each of the two datasets, the observed frequencies are compared to the expected values, based on the proportions per distance zone.

Distance to nearest town	Area (%)	N=1186			N=1944		
		expected	observed	χ2	expected	observed	χ2
<5 km	14	166	228	**23.12**	272	414	**73.92**
5-10 km	41	486	580	**18.07**	797	981	**42.46**
10-15 km	34	403	346	**8.13**	661	492	**43.19**
15-20 km	9	107	25	**62.60**	175	32	**116.81**
>20 km	2	24	7	**11.79**	39	25	**4.96**
TOTAL	**100**	**1186**	**1186**	**123.70**	**1944**	**1944**	**281.34**

Tab. 6.66 Expected and observed number of settlements per distance to town-zone plus the corresponding Chi-squared value, for n=1186 and n=1944.

The Chi-squared values obtained for both datasets can then be compared to the critical value necessary in order to establish the assumed dependence.

	n=1186	n=1944
Chi-square (Observed value)	123.70	281.34
Chi-square (Critical value)	18.5	18.5
D.F.	4	4
alpha	0.1%	0.1%

Tab. 6.67 Results of the Chi-squared calculations for the variable 'distance to towns' for the two datasets n=1186 and n=1944.

The results of the Chi-squared analysis allow for the rejection of the null-hypothesis at the 0.1% level, which means that a statistically significant relation between Roman settlement and the distance to the nearest town is proven for the study area. For both datasets it follows that the region within 10 kms of a town was more densely populated than locations further away. The results in table 6.66 show that wherever the nearest town was more than 15 kms, or 10 Roman miles away, was significantly less densely populated. The fact that the relation between Roman settlement and distance to nearest town is proven can be seen as evidence that the development of the region was highly influenced by the new situation. This presumably indicates a break with the settlement pattern of previous periods when these towns did not exist.

Distance to town – type of rural settlement

The next analysis examines the relation between the two main types of settlement and the new towns.

Distance to nearest town	**area (%)**	**N=1186 post-built**			**N=1186 stone-built**		
		expected	**observed**	**$\chi 2$**	**expected**	**observed**	**$\chi 2$**
<5 km	14	4	5	**0.51**	160	214	**17.99**
5-10 km	41	11	15	**1.77**	469	562	**18.25**
10-15 km	34	9	6	**0.91**	389	338	**6.76**
15-20 km	9	2	0	**2.34**	103	25	**59.12**
>20 km	2	1	0	**0.52**	23	6	**12.47**
TOTAL	**100**	**26**	**26**	**6.05**	**1145**	**1145**	**114.58**

Tab. 6.68 Expected and observed number of settlements per distance to town-zone according to settlement type plus the corresponding Chi-squared value, for n=1186.

N=1186	**Post-built**	**Stone-built**
Chi-square (Observed value)	6.05	114.58
Chi-square (Critical value)	7.78	18.5
D.F.	4	4
alpha	10%	0.1%

Tab. 6.69 Comparison of observed and critical Chi-squared values for the variable 'distance to towns' for the two types of rural settlement using n=1186.

Table 6.69 shows that a relation between post-built settlements and distance to towns cannot be proven, using n=1186. This means that for this dataset he assumption that the distribution of post-built settlements was not influenced by the new towns, is correct. For stone-built settlements the resultant Chi-squared value allows for the rejection of the null-hypothesis at the 0.1% level, which means that the assumption that this type of settlement was influenced by the new towns, is correct. The region within 10 kilometres of a main town was favored by this type of settlement. Next the dataset n=1944 is tested.

Distance to the nearest town	Area (%)	N=1944 post-built			N=1944 Stone-built		
		expected	observed	χ2	expected	observed	χ2
<5 km	14%	60	101	**27.40**	173	233	**20.55**
5-10 km	41%	177	242	**24.12**	508	604	**18.32**
10-15 km	34%	147	75	**34.93**	421	359	**9.11**
15-20 km	9%	39	6	**27.72**	111	26	**65.49**
>20 km	2%	9	7	**0.30**	25	16	**3.10**
TOTAL		**431**	**431**	**114.47**	**1238**	**1238**	**116.56**

Tab. 6.70 Expected and observed number of settlements per distance to town-zone according to settlement type plus the corresponding Chi-squared value, for n=1944.

N=1944	Post-built	Stone-built
Chi-square (Observed value)	114.47	116.56
Chi-square (Critical value)	18.5	18.5
D.F.	4	4
alpha	0.1%	0.1%

Tab. 6.71 Comparison of observed and critical Chi-squared values for the variable 'distance to towns' for the two types of rural settlement using n=1944.

With the dataset n=1944 a statistically significant relation can be proven for both post-built and stone-built settlements. Again, the pattern emerges that the region lying within 10 kilometres of a main town was substantially more densely populated, this time by both types of settlements.

Dating – distance to towns

If it can be attested that the relation between rural settlements and towns changed over time, whereby the attraction of towns to farmers increased from the early to the middle Roman period, this could be considered as additional evidence for the claim that settlement development in the region was influenced by the new towns built after the conquest in 50 BC. In order to examine the validity of this assumption, the total number of settlements was calculated for each of the three periods (early, middle and Late Roman), and analysed for the variable 'distance to towns'.

Distance to nearest town	Area (%)	EARLY ROMAN N=1186			EARLY ROMAN N=1944		
		expected	observed	χ2	expected	observed	χ2
<5 km	14	11	19	**4.93**	18	28	**6.30**
5-10 km	41	34	46	**4.56**	51	69	**6.15**
10-15 km	34	28	16	**5.06**	43	26	**6.41**
15-20 km	9	7	0	**7.38**	11	0	**11.25**
>20 km	2	2	1	**0.25**	3	2	**0.10**
TOTAL	**100**	**80**	**80**	**21.93**	**125**	**125**	**30.10**

Tab. 6.72 Results of the Chi-squared calculation for the variable 'distance to town', for settlements dated to the Early Roman period, using n=1186 and n=1944.

Early Roman period	n=1186	n=1944
Chi-square (Observed value)	21.93	30.10
Chi-square (Critical value)	18.5	18.5
D.F.	4	4
alpha	0.1%	0.1%

Tab. 6.73 Observed and critical Chi-squared values for the variable "distance to towns' for settlements dated to the early Roman period.

Based on the results presented in table 6.73 it can be concluded that, in the early Roman period, significantly more settlements than expected were located in the zones <5 kms and 5 – 10 kms, and substantially less in the area located at a distance of 10 kms and more, whereby the most significant difference between expected and observed number of settlements can be noted for the zone of over 15 kms. Essentially, this is the same observation as that derived from the overall dataset. What can be concluded from this evidence, however, remains open to debate. Either settlement was influenced by the newly created towns, even in the early days of the region as a Roman possession, or the towns were founded in areas already more densely populated. To establish which of these conclusions is more viable, more empirical data is needed from the pre-Roman period. It lies outside the scope of this study to further examine this issue, but with regard to the transition from the late La Tène period to the Early Roman period it is obvious that this subject requires attention.

Using the data for the middle Roman period, the observed Chi-squared values also result in statistically significant evidence for a relation between the towns and rural settlements. Looking at the individual results for the different distance zones, in table 6.74, below, it is interesting to see that, compared to the numbers for the early Roman period, there seems to be a different pattern. In the middle Roman period, apparently, the most dramatic difference between the number of settlements expected and those observed took place in the zone of 5 to 10 kms, and less in the zone of <5 kms. There were still significantly fewer settlements than expected in the zone > 15 kms.

Distance to the nearest town	Area (%)	MIDDLE ROMAN N=1186			MIDDLE ROMAN N=1944		
		expected	observed	χ2	expected	observed	χ2
<5 km	14	43	48	**0.70**	57	74	**4.99**
5-10 km	41	125	167	**14.40**	167	216	**14.19**
10-15 km	34	103	83	**4.01**	139	110	**5.95**
15-20 km	9	27	5	**18.27**	37	5	**27.40**
>20 km	2	6	1	**4.24**	8	3	**3.26**
TOTAL	**100**	**304**	**304**	**37.38**	**408**	**408**	**52.52**

Tab. 6.74 Results of the Chi-squared calculation for the variable 'distance to town', for settlements dated to the middle Roman period, using n=1186 and n=1944.

Middle Roman period	n=1186	n=1944
Chi-square (Observed value)	37.38	52.52
Chi-square (Critical value)	18.5	18.5
D.F.	4	4
alpha	0.1%	0.1%

Tab. 6.75 Observed and critical Chi-squared values for the variable "distance to towns' for settlements dated to the middle Roman period.

The observed pattern can be considered the result of a natural growth process, whereby settlement started in the region closest to the new towns, and, over the years, spread to areas further away. This may have been because the zone <5 kms offered fewer settlement opportunities, due to the number of established settlements dated to the first century AD. The zone of 5 – 10 kms distance, however, might have offered more settlement opportunities.

Distance to the nearest town	Area (%)	LATE ROMAN N=1186			LATE ROMAN N=1944		
		expected	observed	χ2	expected	observed	χ2
<5 km	14	16	20	**1.28**	20	28	3.32
5-10 km	41	46	62	**5.97**	58	80	8.15
10-15 km	34	38	28	**2.51**	48	32	5.49
15-20 km	9	10	0	**9.99**	13	0	12.78
>20 km	2	2	1	**0.67**	3	2	0.25
TOTAL	**100**	**111**	**111**	**19.76**	**142**	**142**	**29.73**

Tab. 6.76 Results of the Chi-squared calculation for the variable 'distance to town', for settlements dated to the late Roman period, using n=1186 and n=1944.

Late Roman period	n=1186	n=1944
Chi-square (Observed value)	19.76	29.73
Chi-square (Critical value)	18.5	18.5
D.F.	4	4
alpha	0.1%	0.1%

Tab. 6.77 Observed and critical Chi-squared values for the variable "distance to towns' for settlements dated to the late Roman period.

The numbers in tables 6.67 and 6.77 demonstrate that there was still a significant relation between settlements and the distance to the nearest town in the late Roman period. Looking at the individual Chi-squared values per cell it can be established that the largest difference between expected and observed values was in the zone of 5-10 kms, with more settlement than expected, and the zone of 15-20 kms, with fewer sites than expected. Overall, the numbers and the differences between expected and observed were much lower compared to the early and middle Roman period.

Conclusion

Regarding the variable 'distance to nearest town' the results of the statistical analyses seem to confirm the assumption that the establishment of towns in the region influenced settlement patterns in the countryside around them. The zone of 10 kilometres and less away from a town appears to have been favoured by farmers over land lying further away. Interestingly, this preference seemed to hold true for the entire range of settlements, and for each of the three phases of the Roman age used in this study, albeit with subtle differences. However, these assumptions need to be treated cautiously, in particular regarding the early Roman period, as it cannot yet be established whether towns were influencing settlement patterns directly after the conquest, or whether towns were founded in densely-populated areas. Furthermore, as indicated in chapter 3, the number of precisely-dated settlements in the study area is lamentably low, with just one-third of sites in dataset n=1186, and only one-quarter of sites in dataset n=1944. The observations regarding the different periods therefore can be seen as trends, but new dating data is necessary for more definite results.

6.2.2 DISTANCE TO A MAIN ROAD

The final situational factor to be taken into account is that of 'distance to a main road'. The main problem with this variable is that it is difficult to determine which roads should be used in the analysis for best result. As discussed in chapter 4, the dataset for main roads in the regionis seriously lacking, not just for the more well-known road running from *Colonia Claudia Ara Agrippinensium* to *Atuatuca Tungrorum* and beyond, but especially for all other main routes, for example those running from the region to the north. These additional roads would completely change the situation of 'distance to main road', as exemplified by the two maps shown below in 6.20 and 6.21. Map 6.20 is a 'distance to main road' visualisation, based on the main road running from *Atuatuca Tungrorum* to *Colonia Claudia Ara Agrippinensium*, with one diversion to *Aquae Granni*. Map 6.21 shows another 'distance to main road' visualisation, whereby every possible road is included, even speculative stretches, such as *Aquae Granni* to *Iuliacum* and *Traiectum ad Mosam* to *Colonia Ulpia Traiana* via the Roman *vicus* situated at the modern-day town of Gangelt.

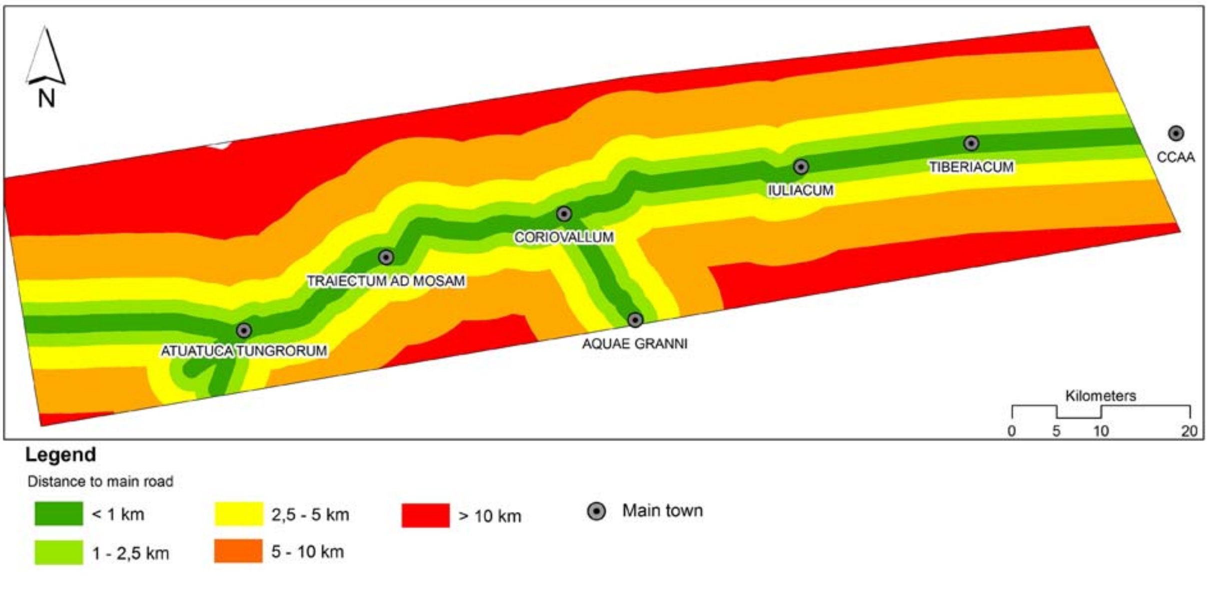


Fig. 6.20 'Distance to main road' visualisation, using the 'Via Belgica' route from Atuatuca Tungrorum to Colonia Claudia Ara Agrippinensium and the road between Coriovallum and Aquae Granni.

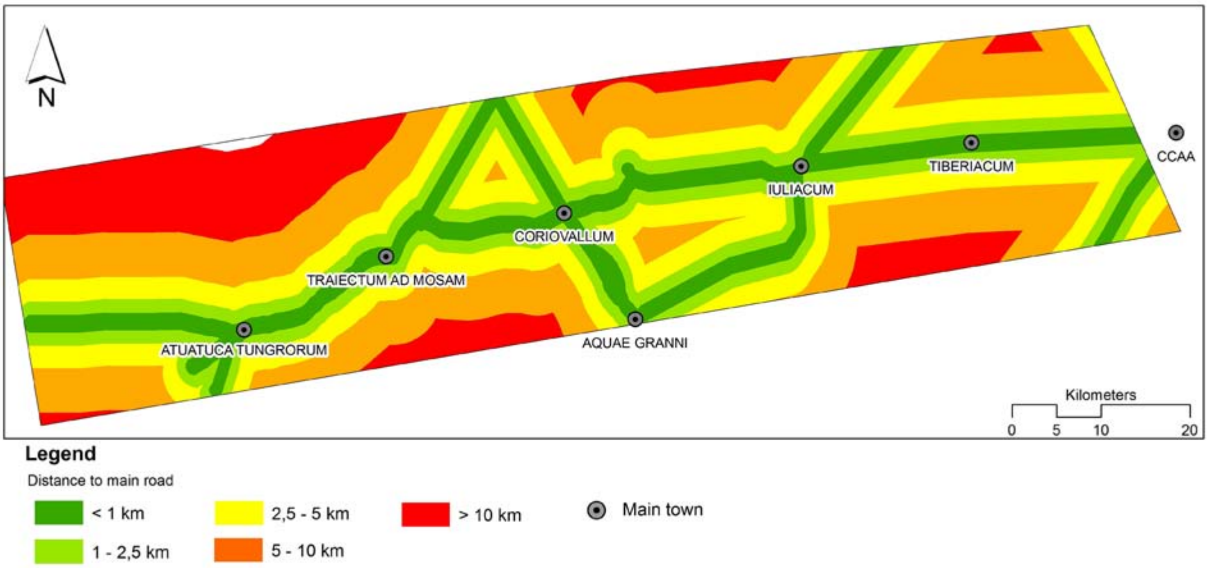


Fig. 6.21 'Distance to main road' visualisation, using every possible route in the region, even those stretches not yet proven archaeologically.

Zooming in on an area northwest of Coriovallum, shown below in figures 6.22 and 6.23, it can be seen that, for many settlements located in this area, the variable of 'distance to nearest main road' changes completely if the possible stretches of roads running north from *Trajectum ad Mosam* and *Coriovallum* to *Colonia Ulpia Traiana* are included.

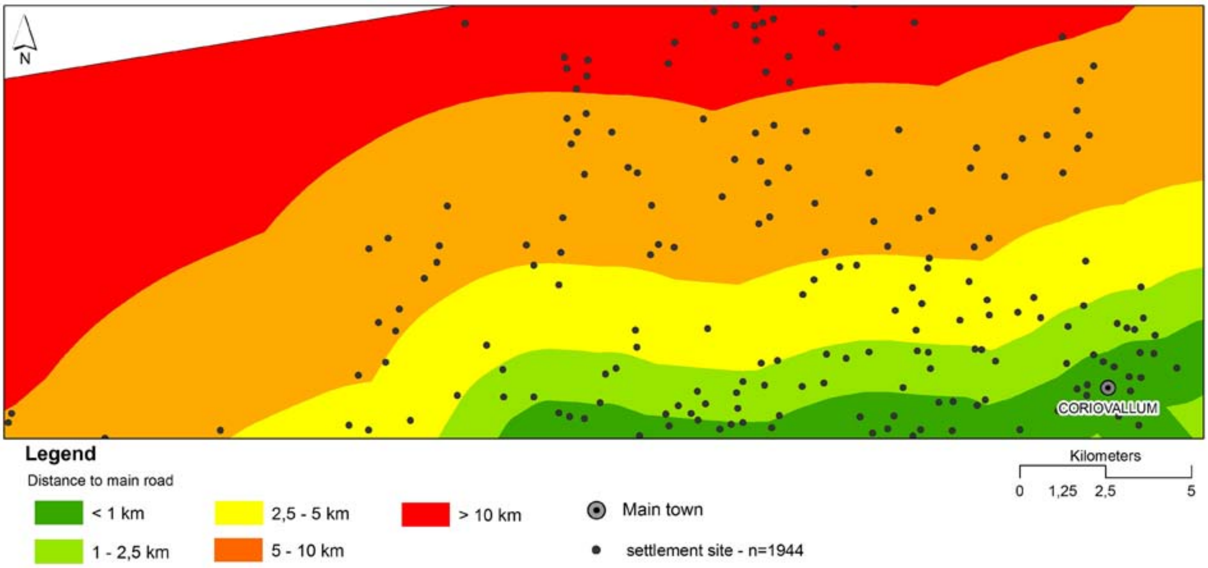


Fig. 6.22 Settlement pattern northwest of Coriovallum, shown with the 'distance to main road' visualisation of figure 6.20.

The problem with map 6.21 and therefore also 6.23, is that not only is it impossible, based on the available archaeological evidence, to determine the existence of the additional stretches of road, but also their exact location. The projection containing additional roads therefore would entail two assumptions, with regards to existence and location, making any statistical calculations highly speculative, and the resultant outcome virtually meaningless as it would be uncertain what exactly has been tested.

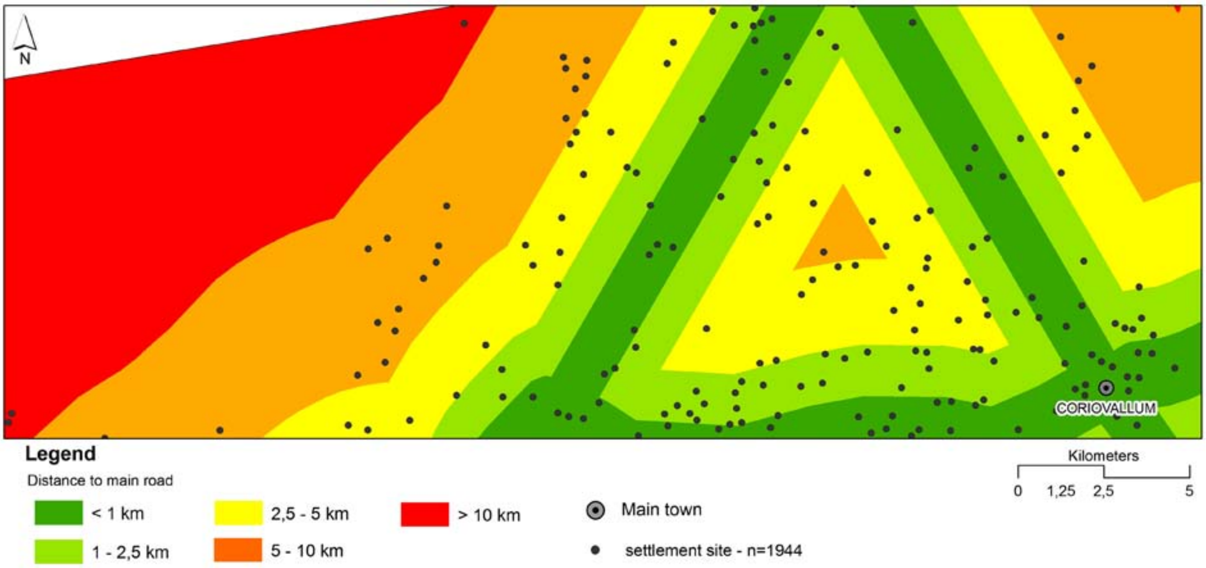


Fig. 6. 23 Settlement pattern northwest of Coriovallum, shown with the 'distance to main road' visualisation of figure 6.21.

Nonetheless, it has to be accepted that other roads than the main road running from east to west were present in the region, but that there is no way to incorporate them into the locational analysis, and that, as a result, the variable 'distance to main road' is less reliable than other variables. The above notwithstanding, the road from *Colonia Claudia Ara Agrippinensium* to *Atuatuca Tungrorum*, known by its unofficial name '*Via Belgica'*, was the most direct connection between not just the the region's towns, but also the two main rivers and between the entire region and the *limes*. This means that it can be considered the most important route in the study. It is believed, therefore, that calculations regarding the distance between settlements and this main artery can provide useful and reliable information regarding the functioning of the main infrastructure and its relation with the rural settlements. Archaeological evidence dated this road to the earliest period of the Roman age,[28] which means that it would have influenced settlement development right from the start, something that cannot yet be proven for any of the other alleged routes.

Unfortunately, even the use of the *Via Belgica* is not without its problems. The main issue is that the location of the road is not known for the entire study area, as was already mentioned in chapter 4. This is particularly true for the stretch of road between current-day Valkenburg and Voerendaal in Dutch Limburg. Therefore it was decided to leave the settlements for which this would be the nearest road out of the calculations. The main road from *Coriovallum* to *Aquae Granni*, however, was included in the analysis.

With the buffer tool in ArcMap, zones were created for five distance zones, as shown in figure 6.20. Their respective areas and corresponding proportions are shown in table 6.78.

[28] See for example Gaitzsch 2004, 186.

Distance to the nearest road Reconstruction 1 (via belgica)	area (ha)	%
< 1 km	31,762	9
1 – 2.5 km	44,958	13
2.5 – 5 km	69,066	20
5 – 10 km	120,249	35
> 10 km	77,179	23

Tab. 6.78 Distance-to-road zones plus their areas and respective proportions.

First the overall datasets n=1944 and n=1186 were used to examine whether the distribution of settlements over the distance zones showed any particular patterning.

Distance to the nearest road (via belgica)	Area (%)	N=1186			N=1944		
		expected	observed	$\chi 2$	expected	observed	$\chi 2$
< 1 km	9	104	169	**40.71**	168	308	**117.02**
1 – 2.5 km	13	150	182	**6.76**	242	339	**38.45**
2.5 – 5 km	20	231	264	**4.71**	373	409	**3.47**
5 – 10 km	35	404	387	**0.74**	653	588	**6.42**
> 10 km	23	266	153	**47.77**	429	221	**100.81**
TOTAL	**100**	**1155**	**1155**	**100.68**	**1865**	**1865**	**266.18**

Tab. 6.79 Expected and observed number of settlements per distance-to-road-zone plus the corresponding Chi-squared value, for n=1186 and n=1944.

	n=1186	n=1944
Chi-square (Observed value)	100.68	266.18
Chi-square (Critical value)	18.5	18.5
D.F.	4	4
alpha	0.1%	0.1%

Tab. 6.80 Results of the Chi-squared calculations for the variable 'distance to nearest main road' –via belgica for the two datasets n=1186 and n=1944.

For both datasets the null-hypothesis of no relation can be rejected, meaning that a statistically significant relation existed between Roman rural settlement and the main roads. The biggest differences between the expected and observed values are that of < 1 kilometer (more settlements than expected) and > 10 kilometres (less settlements than expected). The individual cell values indicate that locations up to 5 kilometres from the main road were favoured, and those further than 5 kilometres avoided. The evidence substantiates the claim that proximity to a Roman main road enhanced the attraction of a particular location for settlement.

Type of settlement – distance to main road

The next relation to be examined was that of settlement type and distance to main road. As with the distance to a nearest town, it could be argued that stone-built settlements were more likely to be located in close proximity to the main roads, due to their role as producers of produce for the interregional market. If post-built settlements were self-sufficient, proximity to a main road might not have been as important. First the Chi-squared values for the two types are calculated using the dataset n=1186.

Distance to the nearest road	area (%)	POST-BUILT N=1186			STONE-BUILT N=1186		
		expected	observed	χ2	expected	observed	χ2
< 1 km	9	2	7	**10.03**	100	150	**24.57**
1 – 2.5 km	13	3	5	**0.94**	145	177	**7.09**
2.5 – 5 km	20	5	7	**0.80**	223	255	**4.59**
5 – 10 km	35	9	5	**1.61**	390	382	**0.17**
> 10 km	23	6	1	**3.92**	256	151	**43.36**
TOTAL	**100**	**25**	**25**	**17.30**	**1115**	**1115**	**79.78**

Tab. 6.81 Expected and observed number of settlements per distance to main road-zone plus the corresponding Chi-squared value, for type of settlement using the dataset n=1186.

N=1186	POST-BUILT	STONE-BUILT
Chi-square (Observed value)	17.30	79.78
Chi-square (Critical value)	13.3	18.5
D.F.	4	4
Alpha	1%	0.1%

Tab. 6.82 Results of the Chi-squared calculations for the variable 'distance to road' for type of settlement using the dataset n=1186.

As both observed values in table 6.82 are higher than the critical values, a relation between both types of settlement and main road can be statistically proven. This means that for both stone-built and post-built settlements the distance to the nearest main road was of influence. This outcome affirms the assumption that the main roads influenced the location of stone-built settlements, but contradicts the idea that roads did not influence the location of post-built settlements. Looking at the individual results per zone, table 6.81 demonstrates that there was no difference in preference for the two settlement types: both favoured locations within 5 kilometres distance of the main road.

The outcome of the analysis for the dataset n=1944, presented in tables 6.83 and 6.84, below, affirms a relation with the main road for both types of rural settlement. As with the dataset n=1186, there seemed to be no difference in preference between the two types. It can therefore be established, based on the evidence presented above, that the main road running from east to west across the study area influenced Roman rural settlement, and that its effect was the same on both post-built and stone-built settlements.

Distance to the nearest road	Area (%)	POST-BUILT N=1944			STONE-BUILT N=1944		
		expected	observed	χ2	expected	observed	χ2
< 1 km	9	36	69	**30.98**	108	168	**32.83**
1 – 2.5 km	13	52	106	**57.32**	157	193	**8.50**
2.5 – 5 km	20	79	87	**0.73**	241	276	**5.15**
5 – 10 km	35	139	90	**17.24**	421	408	**0.43**
> 10 km	23	91	45	**23.49**	277	159	**50.21**
TOTAL	**100**	**397**	**397**	**129.76**	**1204**	**1204**	**97.11**

Tab. 6.83 Expected and observed number of settlements per distance to main road-zone plus the corresponding Chi-squared value, for type of settlement using the dataset n=1944.

N=1944	POST-BUILT	STONE-BUILT
Chi-square (Observed value)	129.76	97.11
Chi-square (Critical value)	18.5	18.5
D.F.	4	4
Alpha	0.1%	0.1%

Tab. 6.84 Results of the Chi-squared calculations for the variable 'distance to road' for type of settlement using the dataset n=1944.

Dating – distance to main road

In this part an examination of the relationship between the distance to the main road and the date of settlements is made. As with towns, it is interesting to find out if the construction of the main road, executed under the reign of August, had an impact on settlement patterns. If this was indeed the case, it is expected that significantly more settlements would be found in close proximity to the road just after it was built, in other words, in the early Roman period. This, too, could be interpreted as evidence of a clear break with Iron Age settlement patterns, and thus provide information regarding the patterns of continuity and change in the region. As time progressed and the zones close to the road became densely populated, it could be expected that settlements would appear in further away from the main road. The two datasets N=1186 and N=1944 will now be analysed per phase, starting with the early Roman period.

Distance to nearest road	Area (%)	Early Roman N=1186			Early Roman N=1944		
		expected	observed	χ2	expected	observed	χ2
< 1 km	9	7	19	**18.81**	11	25	**17.90**
1 – 2.5 km	13	11	17	**3.98**	16	27	**7.82**
2.5 – 5 km	20	16	26	**5.93**	24	31	**1.79**
5 – 10 km	35	28	12	**9.43**	43	26	**6.53**
> 10 km	23	19	7	**7.26**	28	13	**8.08**
TOTAL	**100**	**81**	**81**	**45.40**	**122**	**122**	**42.13**

Tab. 6.85 Results of the Chi-squared calculation for the variable 'distance to main road', for settlements dated to the early Roman period, using n=1186 and n=1944.

Early Roman	N=1186	N=1944
Chi-square (Observed value)	45.40	42.13
Chi-square (Critical value)	18.5	18.5
D.F.	4	4
Alpha	0.1%	0.1%

Tab. 6.86 Observed and critical Chi-squared values for the variable 'distance to main road' for settlements dated to the early Roman period.

The results in tables 6.85 and 6.86 show that the null-hypothesis of no relation can be rejected at the 0.1% point for both datasets. Closer inspection of the individual values confirms the assumption that significantly more settlements had a close proximity to the road, with the highest difference between expected and observed values in the zone of <1 km. At a distance of > 5 kms, significantly fewer settlements dated to the early Roman period are found. These results seem to confirm the assumption that in the early Roman period the presence of the main road in the region influenced settlement, with zones closer to the road preferred over areas further away. In areas located > 5 kms from the main road, significantly fewer settlements were found than expected.

Of course it could be argued that the relation between road and settlements worked the other way round. In my opinion, though, it is difficult to maintain that at the beginning of the Roman period the main road from *Atuatuca Tungrorum* to *Colonia Claudia Ara Agrippinensium* was deliberately constructed to run right down the middle of a long and narrow area of higher settlement, because the settlement pattern of the late La Tène period was of a dispersed nature. Therefore it is quite probable that the observed relation between the main road and early Roman settlement represents the influence of the road on settlements, with farmers preferring a location in close proximity to the main road.

Distance to the nearest road	Area (%)	Middle Roman N=1186			Middle Roman N=1944		
		expected	observed	$\chi 2$	expected	observed	$\chi 2$
< 1 km	9	27	34	**2.09**	35	52	**7.71**
1 – 2.5 km	13	38	45	**1.15**	51	64	**3.19**
2.5 – 5 km	20	59	77	**5.49**	79	97	**4.20**
5 – 10 km	35	103	101	**0.05**	138	136	**0.03**
> 10 km	23	68	68	**13.13**	91	45	**22.97**
TOTAL	**100**	**295**	**295**	**21.92**	**394**	**394**	**38.10**

Tab. 6.87 Results of the Chi-squared calculation for the variable 'distance to main road', for settlements dated to the middle Roman period, using n=1186 and n=1944.

Middle Roman	N=1186	N=1944
Chi-square (Observed value)	21.92	38.10
Chi-square (Critical value)	18.5	18.5
D.F.	4	4
alpha	1%	0.1%

Tab. 6.88 Chi-squared values for the variable "distance to main road' for settlements dated to the middle Roman period.

The results in tables 6.87 and 6.88 demonstrate that the settlement patterns in the middle Roman period had changed in comparison to the patterns of the early Roman period. As a relation can be attested for both datasets, the numbers in table 6.87 indicate that, although there were still significantly more settlements than expected in the zone of < 5 kms from the main road, there are some differences with regard to the previous period. In the early Roman period farmers favoured the zone of < 1 km distance, whereas in the middle Roman period settlements were more evenly spread across the entire zone of < 5 kms, with the biggest difference between expected and observed sites in the zone of >2.5 – < 5 kms. This can be interpreted as evidence of a shift in settlements, from the zone of < 1 km from the main road to the zone of 1> -< 5 kms. Although there did not seem to be significantly more settlement than expected in the zone of >5 – <10 kms, this can be seen as an expansion of the favoured zone, because in the early Roman period it was decidedly less densely populated than expected.

Distance to the nearest road	Area (%)	Late Roman N=1186			Late Roman N=1944		
		expected	observed	$\chi2$	expected	observed	$\chi2$
< 1 km	9	10	13	**0.91**	13	18	**2.13**
1 – 2.5 km	13	14	17	**0.46**	18	24	**1.66**
2.5 – 5 km	20	22	35	**7.38**	28	40	**4.74**
5 – 10 km	35	39	36	**0.21**	50	49	**0.01**
> 10 km	23	26	10	**9.45**	33	11	**14.36**
TOTAL	**100**	**111**	**111**	**18.40**	**142**	**142**	**22.91**

Tab. 6.89 Results of the Chi-squared calculation for the variable 'distance to main road', for settlements dated to the late Roman period, using n=1186 and n=1944.

Late Roman	N=1186	N=1944
Chi-square (Observed value)	18.40	22.91
Chi-square (Critical value)	13.3	18.5
D.F.	4	4
alpha	1%	0.1%

Tab. 6.90 Chi-squared values for the variable 'distance to main road' for settlements dated to the late Roman period.

For the late Roman period the results seem to demonstrate new shifts in settlement behavior. The numbers in table 6.89, when compared to those for the earlier periods, show that the only zone that stands out for the difference between expected and observed number of settlements was that of >2.5 – <5 kms. The results demonstrate that significantly more settlements than expected occurred here. Although still favored, the zone of < 2.5 kms from the main road had only slightly more settlements than expected. The zone of >5 – < 10 kms did not have significantly more or less settlements than expected, as in the middle Roman period, and the zone located > 10 kms from the main road apparently remained unpopular.

Conclusions – distance to main road

The results above prove the assumption that the construction of the main road running from east to west through the centre of the study region (and from north to south between the Roman towns of *Coriovallum* and *Aquae Granni*) in the early Roman period influenced settlement patterns in the countryside. Farmers favoured a zone within 5 kilometres of the main road in preference to more distant locations. Statistically significant relationships were proven for both settlement types (post-built and stone-built), whereby both types favoured the same zone. This seems to suggest that post-built settlements, too, took proximity to the nearest main road into account. The settlement patterns per period can be interpreted as the result of a sequential development whereby the area closest to the main road was predominantly settled in the earlier phase, and settlement increasing in areas further away in the subsequent periods. As with the previous variables, though, further evidence is needed, as the number of precisely dated settlements form only a small part of the entire dataset. Overall it has to be reiterated that for this variable further research is necessary, especially because it is to be expected that more roads were located in the study area, which might change the outcome of a locational analysis performed with the same settlement dataset.

6.3 OBSERVATIONS AND CONCLUSIONS

The goal of this chapter was to investigate which factors could be identified as having influenced rural settlement in the study area. A range of environmental elements, such as soil type, distance to the nearest source of water, and elevation were tested, as well as factors such as the distance to the nearest town. After testing single variables the following conclusions were reached.

There was a significant association between the fertile loess soils and settlement, however, it could not be proven that the preference was strong throughout the entire study area. East of the Meuse, settlement was found on most soil types, with only a slight preference for the fertile loess soils. West of the Meuse, the differences between expected and observed numbers were much more marked. As pointed out previously, further research needs to be carried out to establish whether this is a reflection of a particular research tradition, or the result of an actual difference in settlement behaviour east and west of the Meuse. It was found, perhaps surprisingly, that there was little difference between stone-built and post-built settlements with regard to the preference for soil type. Both types were much more likely to be found on the fertile loess soils, and, interestingly, many stone-built settlements were also found on soils considered to be more marginal, such as the clays and silts.

A relation was also established between settlement and the variable 'distance to water'. Both stone-built and post-built settlements were most likely to be found 500m to 2000m away from a stream. Land within 500m of a stream seems to have been avoided, as well as that more than 2000m away, however, the evidence suggests that stone-built settlements had a preference for the zone of 100 – 250m distance.

A significant relation was also found between settlement and elevation. Overall, it was found that settlement avoided regions lower than 50m and higher than 225m above sea level. Altitudes between 75 and 125m seem to have been favoured. For this variable, differences in preference of the two main types of settlement were found. Few post-built settlements were found in the zone of 75 - 100m, whereas stone-built settlements on the other hand were significantly absent from the higher altitudes (175-225m).

Closer inspection of the study area for the variables slope and aspect revealed that, only in the region of Dutch Limburg, was the land shaped in such a way that these factors significantly could have determined settlement conditions for specific locations. When testing the settlement dataset for this part of the study area, it was found that slopes between 2 and 4% seem to have been preferred by settlements. However, a relationship between settlement and aspect could not be established.

Particular preference for land located at a certain distance to both main roads and towns in the region was also established. Land lying within 10 kms of a town was preferred by both post-built and stone-built settlements alike, as well as that lying within 5 kms of a main road. It was even possible to explore the sequential development of the countryside in this respect, whereby land lying closest to the new road and towns appears to have been settled first, followed by land further away in the later periods.

Comparing variables by means of visual inspection of the preferred zones led to the conclusion that, of all variables, soil type, distance to towns and distance to the main road seem to have been the most influential factors in the development of the Roman rural landscape in the study area. Therefore it is to be expected that land falling within all of the preferred zones of these three variables would have been densely populated. These results can be interpreted as being a reflection of a particular settlement strategy, whereby soil type, accessibility to main arteries and proximity to markets were apparently of the utmost importance. It does not seem far-fetched to conclude that this strategy can be tied directly to the development of the region as a main provider of food for regions where conditions were not as optimal, but where the demand for food was high, such as the military zone along the river Rhine.

The results in this chapter also shed light on the relationships between stone-built and post-built settlements and their environment. It was explained that if they were evidence of two different life styles, it would be expected that they had different relationships with their environment. For example, if stone-built settlements are expected to have been producing a large surplus, to be sold on the interregional market, this would result in different demands regarding its location than a self-sufficient (post-built) farm. However, the expected obvious differences in settlement strategy did not really materialise. In most cases it was found that post-built sites were found in the same locations as stone-built sites. Both types favoured the more fertile soils, the same distance to water zones, the same slope class and even the same 'distance to town / distance to main road' zones. Does this mean that post-built farms had the same life style as the stone-built settlements?

It is suggested here that the results of this chapter can be seen as evidence that the post-built sites were predominantly dependent on stone-built settlements, before any other environmental factor. For this I refer to parts 5.5 and 5.6 in the previous chapter. There it was argued that the Roman landscapes in the study area were densely populated, with approximately 3 to 4 settlements per square kilometre, whereby one or two of the settlements were of the stone-built type, and the other two post-built. In order to successfully work the land, seasonal labour in addition to regular labour would have been needed. If not all workers lived on the stone-built settlement (the villa), it was suggested that some of the labourers (regular and/or seasonal) lived with their families in single-farm settlements, located amongst the larger stone-built settlements. If these single-farm settlements were of the post-built type, then it is not difficult to imagine that the location of such a farm was determined solely by the need to be close to the stone-built settlement where the family was employed. This means that the preferences with regards to the environment attested by the stone-built sites, also applied to the post-built sites.

Of course the problem with the current dataset (n=1186) is the small number of post-built sites. Therefore many of the Chi-squared analyses could not be performed, because too many cells in the calculation had an expected value of 0. Although the dataset n=1944 gave good results, it can always be argued that, due to the nature of the more liberal definition of what substitutes a post-built site (see chapter 5), these results are not sufficiently reliable. The only solution to this problem is new data regarding the post-built settlements, preferably in the form of new excavations, especially at those sites where small find assemblages were found by field surveys.

Another issue that needs to be addressed here concerns the discussion in chapter 5.4, where it was argued that differences in Roman settlement density are largely due to distinct archaeological practices in the three countries comprising the study area. It was shown that areas with high settlement density coincided with the region where the German *Ambt für Bodendenkmalplfege Rheinlands* carries out a programme of systematic field surveys and extensive excavations. To prove this assumption, the settlement density map was compared to different environmental factors, none of which could sufficiently explain the observed differences in settlement density. In light of the conclusions regarding the influence of specific environmental factors on settlement in the region, this argument will be looked at again.

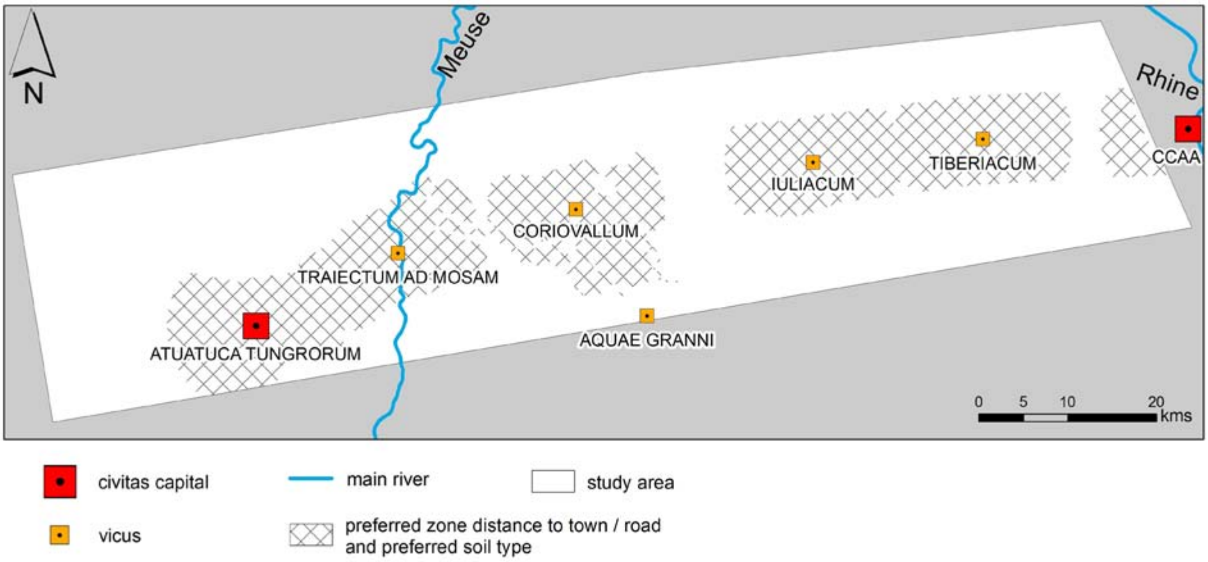


Fig. 6.24 Map of the raster dataset showing where the preferred zones of the variables soil type, distance to town, and distance to main road, overlap.

The Chi-squared analyses in this chapter tested the perceived influence of individual factors on Roman rural settlement in the region. This of course was a different process than trying to explain areas of high settlement density in terms of specific environmental circumstances, which was done in chapter 5.4. The results of parts 1 and 2 in this chapter showed that soil type, in combination with distance to the nearest town and distance to the nearest main road, influenced settlement the most. It makes sense to identify those areas where all three of the preferred zones coincide, and compare them to the settlement density map.

In ArcMap a new raster dataset was made, using the 'intersect' tool of the Analysis tools, that shows where the three preferred zones of the variables soil type, distance to town and distance to main road overlap. This is shown in figure 6.24, above.

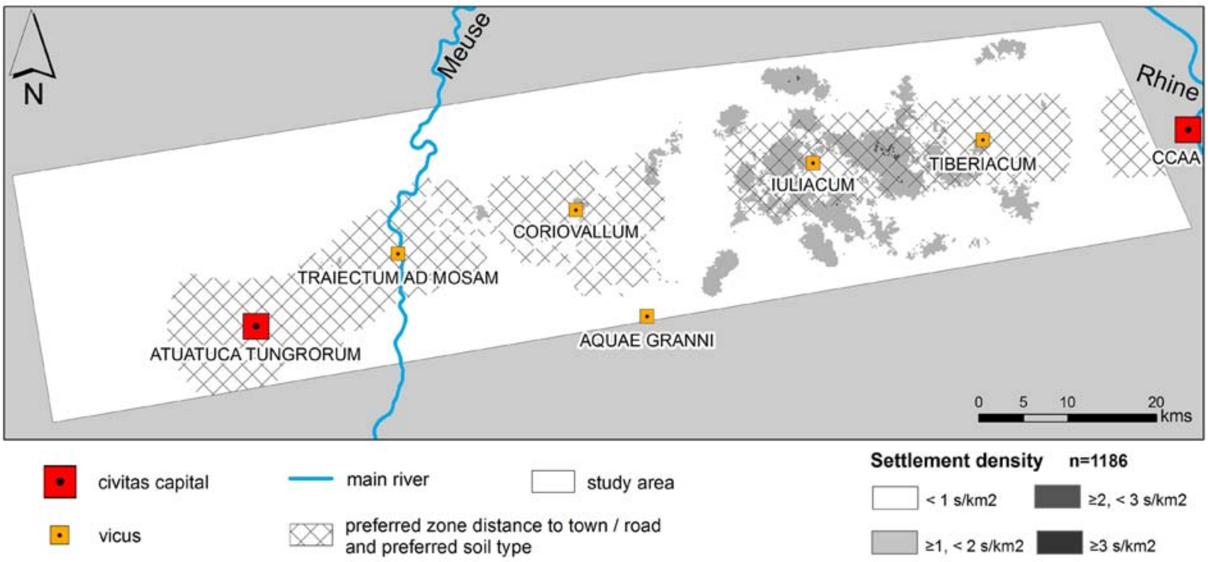


Fig. 6.25 Map of the raster dataset showing the raster for 'preferred zones' against the settlement density map based on the dataset n=1186.

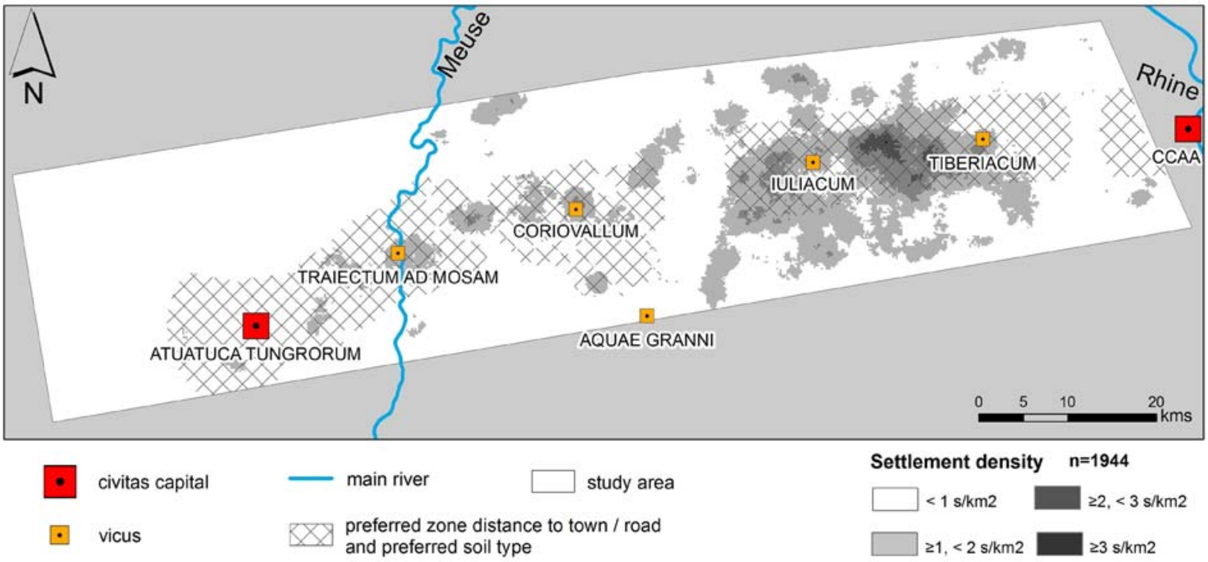


Fig. 6.26 Map of the raster dataset showing the raster for 'preferred zones' against the settlement density map based on the dataset n=1944.

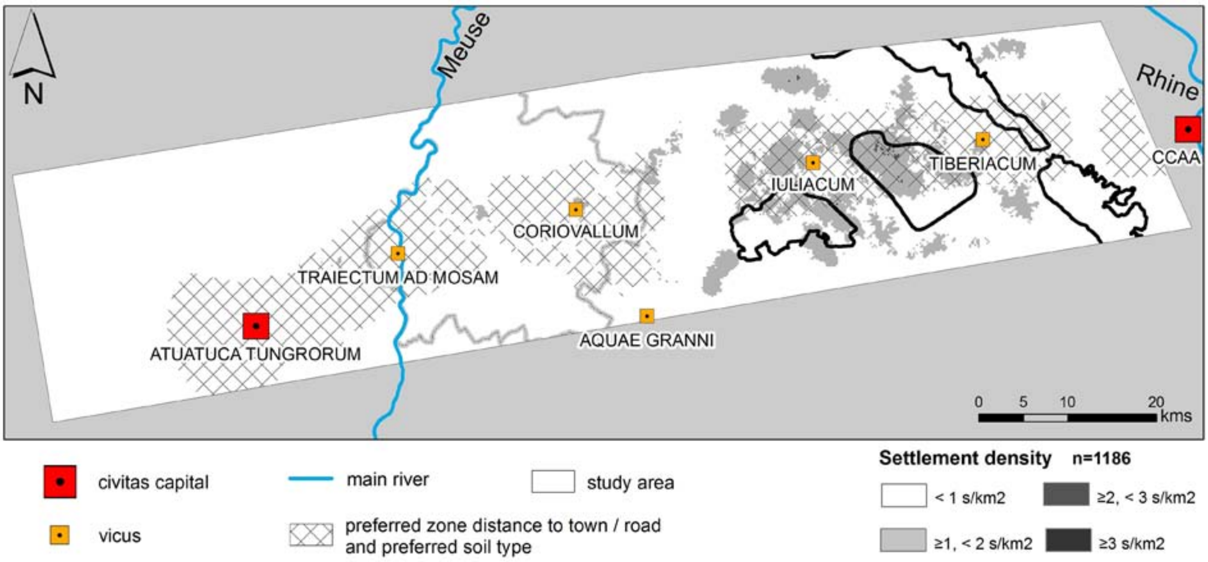


Fig. 6.27 Map showing the raster for 'preferred zones' and the settlement density map based on the dataset n=1186, against the location of the lignite mines (indicated by the bold black line) and the border of Dutch Limburg (grey bold line).

The next step is to project this raster of preferred zones onto the settlement density maps, for both settlement datasets n=1186 and n=1944. The resulting maps are shown in figures 6.25 and 6.26.

Inspection of these maps demonstrates that although the areas of highest settlement density fall within part of the area of 'preferred zones', other parts of the 'preferred zones' show a low settlement density. . In other areas high density numbers are observed outside of the raster of 'preferred zones'.

To the maps shown in figures 6.25 and 6.26 the location of the lignite mines and the border of Dutch Limburg are added. This allows for a comparison of the areas of highest settlement density, the location of the 'preferred zones' raster, and the modern-day situation in the region. Clearly the loca-

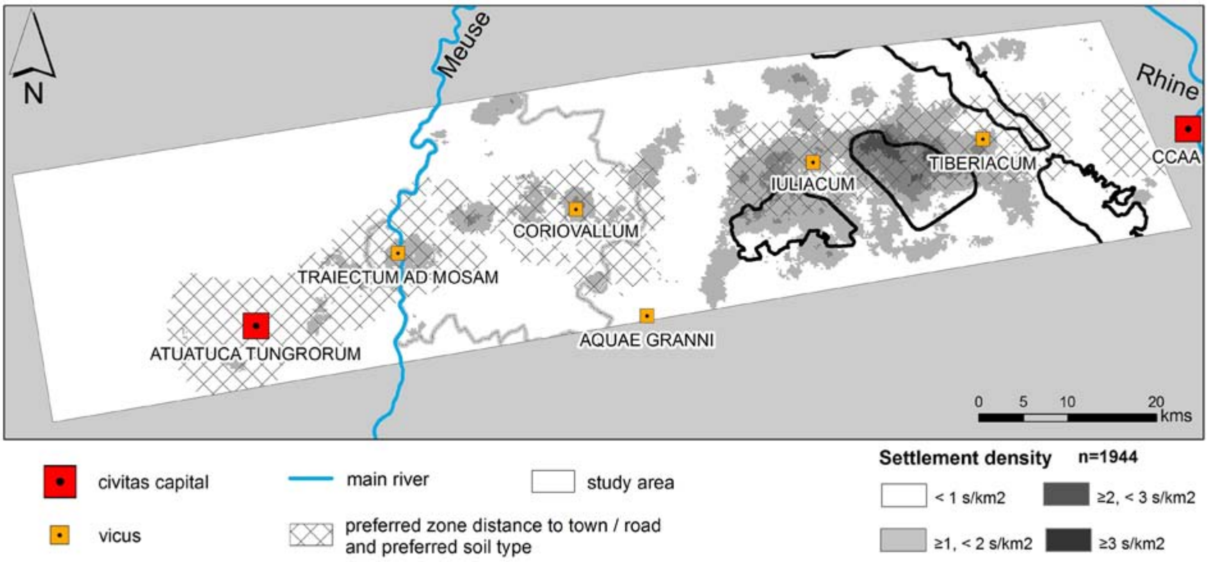


Fig. 6.28 Map showing the raster for 'preferred zones' and the settlement density map based on the dataset n=1944, against the location of the lignite mines (indicated by the bold black line) and the border of Dutch Limburg (grey bold line).

tion of the lignite mines remains the only obvious element that can be related directly to the areas of highest settlement density, for both datasets.

The observed relationships between environmental factors and Roman rural settlement in the study area remain undisputed. Nevertheless, the above shows the impact of archaeological practices on our knowledge of the Roman settlement landscapes in the region. In my opinion, it must be seen as irrefutable evidence that new research and new archaeological data are necessary, in order to create a reliable reconstruction of the Roman landscapes in this part of the empire.

7. Summary and recommendations for future research

This study explored the potential of the archaeological dataset to improve our understanding of the Roman landscape in the loess-region between Tongres (Belgium) and Cologne (Germany), using a variety of methods and tools. As the results of more than 150 years of archaeological research were registered, mapped and analysed, a wealth of information regarding the landscape, in addition to the archaeology itself, was collected. This final chapter presents the main findings of the study, and suggests recommendations for future research.

7.1 RESULTS OF THIS STUDY

The aim of this study mapping the results of 150 years of archaeological research in three different countries in order to reconstruct the different elements of Roman life in this part of the empire has shed light on a wide array of topics. Although not all of the lines of inquiry introduced in chapter 1 could be followed, at least some of the most important questions were answered.

Some of these answers were not sought intentionally. It came, for example, as a surprise how influential the different archaeological traditions in each of the three countries comprising the study area turned out to be. The time spent on data collection resulted in a profound knowledge of the histories of archaeology in each country, pertaining to the prevailing methods, the most important excavations and sites and the most influential researchers. This, it turned out, was vital knowledge to gain a full understanding of the dataset. It made assessing the reliability of each individual item in the basic dataset significantly easier. The influence of differing archaeological traditions on the resulting maps, however, was completely unexpected. It was found that the variance in settlement density in the region, presented in chapter 5, is largely due to modern-day archaeological practises, rather than environmental circumstances in the Roman period. This was something that would have been hard to establish without extensive knowledge of the archaeological traditions in each country. These outcomes should also be seen as an incentive to actively look at what is done, in archaeological terms, in neighbouring countries. This is difficult given the situation most archaeologists find themselves in today, with budgets, deadlines and the competitive tendering process leading research agendas. It is hoped, therefore, that the results of this study will encourage archaeologists to reflect on past archaeological practises and prevent them from underestimating their influence in the past and today.

Upon embarking on this study, the goal of mapping the Roman landscapes seemed a straightforward task. At the end of the data acquisition phase, however, it became clear that the diversity in information, especially in terms of quality and reliability, was such that the production of the desired map almost seemed an impossible task. The fact that most national archaeological databases register archaeological findspots, rather than features such as settlements or cemeteries, generated difficulties in particular. This led to a realisation that the basic dataset would have to undergo a reappraisal in order to produce the desired maps. Use of geo-software, in this case ArcView, facilitated this reappraisal process. It allowed for the inspection of every single item registered in the first dataset, in terms of the archaeological information and the actual location of the material. Together with criteria for the characterisation of data, it was decided to introduce three levels of interpretation. This helped to gain information about the composition of the dataset and also made for homogeneity, within the overall dataset, and within the different categories that were used. The reappraisal, executed according to guidelines and criteria formulated specially for the Roman landscape in the study area, resulted in a homogeneous, reliable, dataset that allowed for interregional comparisons. It also eradicated biases caused by differing archaeological traditions, not only in the three countries, but also over more than 150 years of research. Although this reappraisal was unplanned, it proved to be a valuable exercise. The results provided a solid basis for the reconstruction of the settlement landscape; the reappraisal method itself can now be used in other similar landscapes, where the same problems of data heterogeneity exist.

The next step in this study was the reconstruction of the settlement landscape. This entailed a second evaluation of the dataset, whereby all sites containing settlement evidence were analysed again with focus on the archaeological material and its location. Based on the spatial dimensions of excavated settlements in the region, guidelines were formulated that were used to decide which sites to map individually and which to merge together into one settlement. Thus, a new settlement dataset was formed using the strictest criteria. Next, funerary evidence was used to identify possible settlement, based on archaeological information that burials were nearly always located in close proximity to settlements. Again, this was based on actual observations from the study area. This resulted in a second dataset, that used funerary sites as evidence for potentially undiscovered settlements. The last step consisted of a reappraisal of find material assemblages that could not be characterised according to the criteria formulated in chapter 3. This was a group of considerable size. It was argued that these often humble find material assemblages could be considered as evidence for small post-built settlements, possibly single farmsteads. Working with that assumption, a third dataset was created. This way three settlement datasets were made, each with a different character.

Two of the new datasets, the smallest, consisting of 1186 sites, and the largest, consisting of 1944 sites, were then used in several analyses and calculations. The advantage of working with two, rather than one, datasets was that they offered ranges, and explored minimum and maximum values, for example regarding settlement density and demography. Interestingly, the 'behaviour' of the two datasets, though fundamentally different in nature, was by and large the same with regard to the influence of environmental factors. This could be seen as evidence for the validity of the assumptions made that certain types of funerary evidence and even small concentrations of find material can be considered reliable indicators of Roman rural settlement in the region. However, further research, preferably through excavated evidence is needed to substantiate this claim.

An important aspect of the second and larger dataset (n=1944) was the proposed proportion of post-built settlements. Although the assumptions behind the interpretation of certain small finds assemblages as evidence for a post-built site may be liberal, the scenarios it produced potentially provoke new ways of thinking about the landscapes on the loess. In the smallest dataset (n=1186) only 3% of all sites were interpreted as being of the post-built type. This means that according to the most strict criteria, 97% of all settlements in the study area were of the stone-built type. In the large dataset (n=1944) the post-built settlement was still a minority at 35%, but it showed the possibility of a large number of rural sites that until now appeared to have been missing from the archaeological record in the study area. Focusing on the results of systematic surveying and excavations in the lignite mining region in the German Rhineland, it was demonstrated that here the proportions of stone-built to post-built sites might have been equal, which is important information for the reconstruction of the social organisation of the rural landscape (see below).

The issue of settlement density in the region was explored using the two settlement datasets. Using the dataset of 1186 settlements produced a density of 0.33 sites per km^2. Use of the dataset of 1944 sites resulted in larger areas of a higher density, in some areas as high as 4 sites per km^2, but showed that in many parts of the study area density remained lower than one site per km^2. However, it was argued in chapter 5.4 that these averages are due largely to bias created by modern-day archaeological practices, rather than being a reflection of the situation in the Roman period. The main evidence for this claim is based on the observation that the highest density is found where a combination of non-invasive and invasive archaeological research methods has been systematically applied to an entire region. A combination of highly favourable environmental circumstances could not be attested in these areas. Based on the results of the best-researched micro-regions of the study area, southwest and east of the German town of Jülich, a settlement density of 3 to 4 settlements per km^2 was proposed as a realistic scenario for the entire study area. Regional variety in settlement density as a result of cultural factors other than the ones tested in chapter 6 remains an option. This would require further investigations, preferably based on new field work.

In chapter 5.4 possible demographic scenarios were explored. Firstly values for the entire study area were calculated, based on the actual settlement density numbers. This resulted in an estimated population of between 17,000 to 28,000, based on an average of 15 people per settlement. The next step was to calculate scenarios based on the four settlements per km^2 density proposed earlier. This resulted in an average of 206,000, or 60 people per km^2. These numbers were then used to explore the topics of territory size, labour force, and living arrangements at settlements. It was suggested that a composition of two smaller villas and two single (post-built) farmsteads per km^2 would constitute a realistic scenario, whereby the two villas exploited 45 hectares each, and the two small farms 5 hectares each. Every villa would house 3 of the 4 labourers needed on a permanent basis, with the other labourer living on the small farm. Although much more research needs to be done on this topic, it is hoped that the scenarios presented here demonstrate archaeologically viable models for the Roman agricultural world. In my opinion, research weaknesses such as the amount of labour, both permanent and seasonal, necessary to work the land, and where these labourers lived, need to be addressed in future research. If not, settlement density remains an almost abstract phenomenon that has little to do with the reality of Roman farming.

The settlement datasets created in this study were sufficient to answer the majority of research questions regarding settlement patterns and organisation. It has been shown that the study area was a predominantly rural landscape, with only 1% of all sites being characterised as 'towns/small towns'. The range of settlements turned out to be more diverse than merely the traditional 'town' - 'villa' – 'native farm'. Starting with the settlements with an urban character, there were the 'official' towns of *Atuatuca Tungrorum* and, located just outside of the study area, *Colonia Claudia Ara Agrippinensium*, with quadrangular lay-outs. Next there were the 'unofficial' towns, such as the *vici* of *Iuliacum* and *Coriovallum*, which appeared to have developed much more organically, and small ribbon settlements, such as those found at Rimburg (Dutch Limburg) and Baesweiler (German Rhineland). The reappraisal of the settlement dataset further identified a possible fourth type, named 'concentration of habitation' in this study. These concentrations were not located on main roads and could only be identified because of overlapping buffer zones (see chapter 5). What this type of settlement constituted of remains unclear at present, due to a lack of detailed information.

Sites with a rural character were also more diverse than previously thought. This study, primarily based on survey evidence, avoided the use of the term 'villa' as the main distinguishing factor was considered the type of building material. Hence the use of terminology such as 'stone-built' and 'post-built'. The group of stone-built settlements turned out to be the dominant settlement type, regardless of which dataset was used. However, exploration of the different variables of each stone-built site showed a considerable diversity within this group. By focussing on specific variables (such as lay-out of a settlement, number of rooms, and the presence of villas and certain architectural and decorative elements) it was possible to identify several discrete 'types'. Some of these were arguably 'richer' than the others and it is tempting to identify them as dwellings of the elite. However, more information is needed, preferably in the form of extensive new research, before any such claims can be validated. Nevertheless it is remarkable that, in comparison to other 'villa-dominated landscapes' in the North, most excavated stone-built settlements in the study area were quite modest, consisting of small and medium-sized villas, with only two ‘palatial’ sites. This evidence seems to substantiate the assumptions made by other researchers regarding a ‘middle class’ of farmers at villa settlements, in addition to the upper class of landowning elite.[1]

Settlements built without any typically Roman building material (concrete, natural stone, and ceramic building materials) appear have been largely overlooked in the past in the study area. Recent excavations have, however, proven the presence of post-built settlements dated to the Middle Roman period, consisting of several contemporaneous houses.[2] New research into the status, function, and development of this type of settlement is badly needed. In the chapter on settlement density scenarios (chapter 5) it was suggested that labourers and their families might have lived in single-farm settlements on the edges of the estates where they were employed. Archaeological evidence to substantiate this claim is limited, however it was thought that the small finds assemblages scattered amongst the larger sites might represent such small single farms. Excavations of such find spots, often detected through field surveys, could help to establish the validity of this assumption. If it turns out that no such farm-type existed, however, this has serious implications for our understanding of the social organisation of the region. If the supposed ‘working class’ of farmers is nowhere to be found in the form of a separate type of settlement, this means that either they were living somewhere else, or that our notions of the assumed ‘upper’ and ‘middle’ class farmers, and where they were living, should be readjusted. Further research in this topic would be welcome.

It has also been argued here that the different types of rural settlements (stone- and post-built) were found in more or less the same landscape zones, and that larger and smaller stone-built settlements were found throughout the study area, without any obvious clustering. The locational analyses performed in chapter 6 indicated that, in general, soil type, in combination with distance to the nearest town and distance to the nearest main road ,were the most influential factors on rural settlement, stone-built and post-built. Obvious differences in preferences for certain locations for the two main types of settlement did not materialise. The most likely explanation for this observation is that post-built sites housed the labour force necessary to work the fields belonging to rural estates.

The exploration of the settlement dataset in the study area resulted in the identification of a settlement system consisting of several types of sites, urban and rural, based predominantly on the presence or absence of certain archaeological indicators. To include additional factors to complement the material aspect, such as social status and economic functioning, would require additional research, but it is hoped that the study at hand has provided a sufficient basis for such studies.

Overall, the changes in the settlement landscape of the study area during the first centuries AD were profound and widespread. Within the course of a century, stone, mortar and ceramic building materials were used to construct houses and buildings throughout in the study area. It is clear that the stone-built settlements became the dominant type in the region. Virtually every excavated stone-built rural site was laid out with a enclosed rectangular farmyard where the main house and the auxiliary buildings were located. All of this indicates that the landscape within the study area underwent a dramatic transformation, starting in the early Roman period, and ultimately resulting in a true ‘villa-dominated’ landscape.

Unfortunately, detailed dating information was very limited for the majority of the dataset. Although some patterns could be reconstructed through time, the dating evidence was such that it was difficult, if not impossible, to provide anything more than a very general pattern of “rise and decline” of the Roman settlement system from the first to the fourth century AD.

1 Roymans / Derks 2011, 27; see also chapter 1 of this study.

2 At Veltwezelt, Kessel, and Heerlen-Trilandis.

Attempts were made to reconstruct the landscapes of production by mapping specialist craft evidence, in addition to the assumed surplus production of agricultural products. However, ths proved difficult because information relating to specialist craft activities in the region was rather limited. This could mean, on the one hand, that craft activities played only a minor role in the region. On the other hand, though, it is believed that because of the traditional research focus being on the stone-built farms and their agricultural production, the topic of craft production has been neglected. It is clear that many of the craft activities took place in the new towns and villages in the region. Evidence for craft production in the *vicus* of *Coriovallum*, for example, is impressive, with tools suggesting a wide variety of specialist activities, such as carpentry, smithing, stone carving, production of ceramic building materials and pottery making. Unfortunately this evidence has only been studied at a basic level, thus prohibiting any estimate of the size of craft production in this small town. As the material is often not dated, it is difficult to indicate when these activities developed and when they disappeared. This is true for the majority of evidence for craft production. What the non-agricultural production contributed to the regional economy in general is therefore difficult to assess at this moment in time.

Another topic that could not be explored as fully as the category of settlement was that of religion via cosmology, ritual and beliefs. Although it was possible to register and map a large number of sites with funerary evidence, other sites that could provide information regarding this aspect of society, such as sanctuaries, were only found in extremely small numbers. The distribution of the monumental funerary evidence, with a marked difference between the area with *tumuli*, and the area with monumental stone burial markers and large stone incinerary urns ("sarcophagi"), could be seen as evidence for the territory of the *civitas Tungrorum* on the one hand, and the *civitas Traianensis* and *civitas Agrippinensis* on the other. It had to be concluded, though, that the majority of the funerary evidence was undated, which is lamentable as the evidence itself typically consists of intact objects with good dating potential. However, use was made of the wealth of funerary evidence by reinterpreting some of the dataset as an indicator for settlement sites.

Overall, this study aimed to explore the spatial order and internal differentiation of the Roman landscapes on the loess soils between Tongres and Cologne. The general objective was to reconstruct, on a landscape-scale, the main aspects of the provincial-Roman world that developed there in the first three centuries AD, using empirical data generated over the last 150 years. Extensive use was made of GIS-technology to explore the dataset, to reinterpret sites, to identify specific elements and patterns, and to analyse the settlement landscape in relation to its environment. The results, it is hoped, have demonstrated the potential of the landscape approach, the use of methods of interpretation an reappraisal designed especially for the region, and the wealth of quantitative information that can be obtained from a region by means of different techniques and analyses. Suggestions for potentially fruitful avenues of future research will now be presented in the next part of this chapter.

7.2 RECOMMENDATIONS FOR FUTURE RESEARCH

Unfortunately, one of the main revelations of this study was the amount of unresolved issues in the dataset relating the Roman landscapes in the study area. Many of these are of a basic character, such as dating. Furthermore, limits to the amount of work that could be done in this study meant that several research topics were touched upon, but unfortunately no elaboration could be made. These issues and topics will now be presented as recommendations for future research.

One of the first recommendations would be to start work on the large number of find assemblages that, until now, have not been studied in detail. It is believed that, certainlyfor the Dutch material, much is to be gained from a detailed study of pottery, metal and coins of a large number of sites, including burials. During the data acquisition phase it was found that many of the finds were administered well, and the archives and depots in Heerlen and Maastricht, for example, offer plenty of research possibilities.

Another possible topic for future research, related to the first, would be publication of excavation results for some of the stone-built settlements excavated long ago. In Dutch and Belgian Limburg, especially, there is a wealth of information waiting to be disclosed. Although the quality of the original excavation documentation can be an issue, it would, in my opinion, be worth investigating how much is available, and what the quality is, so that a maximum of information can still be obtained from these sites, especially in light of innovations in several fields in archaeology.

In Belgian and Dutch Limburg the (much) lower site density numbers raised question marks regarding the reliability of these numbers, especially since it was demonstrated (in chapter 5) that modern-day archaeological practices have created a significant bias. In the lignite mining area, systematic field surveys are carried out together with other archaeological methods, and it can be reasonably assumed that these surveys are a main contributing factor to the (much) higher site density in the German part of the study area. Therefore it would be interesting to see whether systematic field survey programmes in Belgium and Dutch Limburg would result in the discovery of substantial numbers of new sites. This could be combined with a systematic aerial survey programme, since this type of research has been very successful in landscapes with similar circumstances, such as the north of France.[3] When this kind of research effort would still result in 'empty' landscapes, only then can it be concluded that settlement density really was lower west of the Wurm river.

Due to a lack of information regarding specific types of site it had to be concluded that many of the research questions relating to the topics this study set out to analyse were left unanswered. One of these was, not surprisingly, the chronology of the region, in particular patterns of continuity and change. The transition from the Late La Tène period to the Early Roman period is difficult to reconstruct due to a lack of well-dated sites. The same problem exists for the transition from the Late Roman period to the Early Middle Ages. A detailed and reliable reconstruction from the transitions at the beginning and end of the Roman period poses a serious challenge without substantial new data for the periods involved. It is hoped that new research in the region will follow this line of inquiry.

Another topic deserving serious attention is that of non-agricultural production. The evidence presented in chapter 4 regarding specialist craft production hinted at the possibilities that the region has to offer regarding the development of craftsmanship in the Roman period. Pottery and glass production are just two of several crafts that were executed in the region; there is ample evidence for these new professions, but little synthesising work has been done on any of it.[4] A quantitative study focussing on Roman craftsmanship, the volume of its production, and details on trading and transportation in the region could shed light on a whole new aspect of society in this part of the empire.

Another subject that could only be treated on a minimal level, was that of religion. The lack of sanctuaries in the region surely cannot reflect the situation in Roman times; the wealth of funerary evidence is a powerful provider of information in this respect that luckily has been studied within the framework of the Roman villa project.[5] It would be interesting to see what an in-depth study on the beliefs of the people in the region would produce.

Chapter 4 noted that reliable archaeological evidence for the road network system of the region is severely lacking for the Belgian and Dutch part of the study area. Even the main road running west-east has not been fully traced there. The other main roads, connecting the region to the north and south, should definitely be examined further. The results in the Hambach region regarding secondary roads show that off-site investigations are necessary if the entire road network is ever going to be

3 Agache 1978.

4 Rothenhöfer 2005 is evidence of the potential of this subject in the region.

5 Crowley 2011.

known. A combination of predictive modelling and non-invasive, ground-penetrating methods definitely offer interesting possibilities in this respect, and should be investigated further.[6] A third topic relating to communication networks are the crossings at smaller waterways, such as the Geul river. Undoubtedly bridge constructions were used to cross these minor streams; if these crossings were to be found, the possibility of timber piles still surviving in situ in the river beds could help determine their date through dendrochronology.

Thankfully there was sufficient settlement data available in the study area to answer some of the questions with regard to the topic of settlement dynamics. Nevertheless, the bias towards stone-built Roman settlements resulted in a lack of knowledge about post-built sites, and recent excavations of such sites has shown that there is definitely more of this type of evidence than previously thought. It is hoped that post-built Roman settlements remain on the research agenda and that new excavations will shed more light on this important element of the settlement landscape. Testing by means of excavating survey sites identified in the German region as '*Funde die auf Siedlung weisen*' (finds that hint at a settlement) could help to establish whether they really do represent (single) post-built farms. Only when much more data regarding post-built farmsteads becomes available can the assumptions made in this study with regard to proportion, location and function be tested.

In general it is hoped that future archaeological research will focus on the diversity of the provincial-Roman landscapes, not just in the study area, but also elsewhere. Interregional comparisons are necessary to evaluate and appreciate the regional variety in provincial-Roman settlement landscapes. Quantitative, rather than qualitative studies, would be welcome in that respect.

This study reconstructed settlement landscapes using different types of archaeological evidence. The scenarios resulting from this exercise were used to explore possible demographic models. The main flaw of these calculations was that they could not incorporate the spatial dimension of demography. The question of seasonal versus regular labour could also not be fully explored with the available dataset. It is hoped that new studies will be done following this line of inquiry, in order to better test the possible scenarios. Better dating information is necessary to allow for development scenarios, as the current dataset only allows for the reconstruction of rather static demographic estimates. Another problem regarding demography is that in the study at hand the estimates were based on a reconstructed dataset. This made comparisons to other Roman (villa) landscapes difficult, if not impossible, as the methodology used in this study differs from that used in other studies. In most cases datasets are used without reappraisal by means of a spatial analysis or an evaluation of the material found. It would be interesting to see what the settlement density and demographic scenarios would be in other regions if the datasets were reappraised in a similar way. It could be argued that the dataset in this study is more realistic because of the incorporation of biases due to research traditions; future research could test the validity of this claim.

It is hoped that the study at hand has highlighted the many possibilities for future research regarding the Roman landscapes in the study area. New archaeological data is necessary and hopefully this study will encourage field archaeologists and policy makers in the region to ask new questions and explore other research possibilities. One thing can be concluded without a doubt: research into the Roman villa landscapes in the North has only just begun.

6 See for example Verhagen / Jeneson 2012 for the results of predictive modelling for part of the Via Belgica.